A Role for Economics in NOAA Fisheries Habitat Conservation Activities

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Executive Summary

This study recommends ways for NOAA Fisheries to improve its stewardship role for fisheries habitat protection by incorporating more economic analysis when carrying out its statutory responsibilities related to fisheries habitat protection and conservation. Six case studies are used to explore the role that economic analysis is currently playing in NOAA Fisheries treatment of habitat protection issues. The case studies also portray the use of economics by interest groups, including other federal agencies, who are involved in activities that affect fisheries habitat. The role that economics played in each of the cases was critically evaluated and recommendations were made regarding how economics could have been used within the case study to improve the decision process. Each case study was also used to illustrate more general applications of economic analysis that could help NOAA Fisheries carry out its stewardship responsibilities.

Our study concludes that there are tremendous opportunities to use economic analysis to improve the way NOAA Fisheries approaches fisheries habitat protection. NOAA Fisheries already does an excellent job of developing convincing arguments regarding the biological impacts of proposed projects, but these are often cast by others as standing in the way of economic progress. NOAA Fisheries needs the capability to both challenge the often exaggerated claims of economic benefits associated with proposed projects that are likely to have adverse impacts on fish habitats, as well as the capacity to demonstrate the economic costs that result from habitat degradation or loss. We recognize that NOAA Fisheries may have a minor role in the ultimate decision regarding habitat change but also recognize that it is important that providing appropriate economic information may enhance NOAA Fisheries role in the process.

The two issues that are often the focus of habitat protection activities and link environmental and economic impacts are risk and cumulative effects. The economic consequences of cumulative biological effects are often significant but our inability to quantify many of these biological effects, hamper our ability to say anything very meaningful about them from an economic perspective. The situation with respect to risk and uncertainty is different because evaluating risk is an inherent component of economic analysis and is useful even when evidence regarding biological impacts is weak. The unique role of risk in economic analysis has some potentially powerful applications in habitat protection because it can be used to demonstrate that over and above any direct project costs that are being measured; there are additional costs due to the fact that a project may also be expected to increase society's risks. Risk has implications for such issues as habitat mitigation ratios, where the number of replacement acres required per acre of impact must reflect not only the delay in the replacement of habitat services, but the risks that the mitigation project will not perform as expected. Because there is so much risk and uncertainty associated with biological and economic impacts of the activities that affect fisheries habitats, and with the activities that can be used to mitigate for adverse fishery habitat impacts, risk should play a very significant role in NOAA Fisheries attempts to improve the decision process.

Specific recommendations for how NOAA Fisheries can improve the use of economics in the habitat protection area are as follows:

1) Development of inventories and comprehensive literature reviews of habitat values to evaluate the existing state of knowledge regarding the value associated with various habitat types.

2) Eliminate the vast gaps (that will be found in task 1 above) in our knowledge regarding economic values of different habitat types in different regions and at different scales through an active research program.

3) Begin a research program that attempts to quantify the risk-related social costs associated with projects with highly uncertain environmental and economic impacts.

4) Create bio-economic models that quantify cumulative effects of habitat degradation and loss, as well as the economic consequences from beneficial uses of dredge materials.

5) Work with other agencies to encourage development of a regional decision making processes using techniques such as the Structured Decision Approach (section III.C) to develop a comprehensive framework that will guide individual project decisions so that they are not evaluated in isolation from other proposed projects and include a full range of stakeholder objectives and values..

6) Staff NOAA Fisheries headquarters and regions (one economist in each region, coordinated by a headquarters economist) to form a critical mass of economists within the agency working on habitat conservation and protection issues, similar to the staffing strategy for economists working on fisheries management.

7) Coordinate with other NOAA components working on economics of coastal habitat issues (e.g. CZM, Damage Assessment, Coastal Ocean Program, Sea Grant)., and the development of strategic alliances with university centers and non-profit organizations involved in related research.

8) Interact with the Office of Management and Budget to assure that Executive Orders guiding the implementation of benefit-cost analysis and cost-effectiveness analysis reflect the concerns of NOAA Fisheries.

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I. Introduction

Coastal areas are increasingly the focus of a wide variety of economic activities from commercial shipping to recreational fishing, and they all have the potential to adversely affect the function, quality and quantity of coastal habitats for living marine resources. The biological impacts of each activity often have direct and indirect impacts on other activities, and also affect the ability of coastal areas to support them. Beyond a certain limit that is not always known these activities create risks that the economic benefits associated with many coastal activities may be lost either temporarily or permanently.

The Habitat Conservation responsibilities of NOAA Fisheries is carried out by the Office of Habitat Conservation in coordination with NOAA Fisheries Regional Offices and involves seeking a balance that allows economic growth in coastal areas while also protecting the habitat functions on which many coastal activities depend.. Through statutes (e.g., Essential Fish Habitat provisions of the Magnuson Fishery Conservation and Management Act, the Fish and Wildlife Coordination Act) and other means, NOAA Fisheries attempts to promote economic development alternatives that avoid or minimize adverse impacts on fisheries habitat, and also recommends remedial actions in the form of habitat replacement, restoration or enhancement for unavoidable adverse habitat impacts.

NOAA Fisheries is exploring ways that it can increase its effectiveness when working with individuals, businesses and other government organizations in matters that involve impact to fish habitats. One area where NOAA Fisheries has not focused much attention is in developing the economic arguments that support the need for habitat protection and conservation. The purpose of this study is to examine NOAA Fisheries Habitat Conservation activities and seek ways that economic analysis can be brought to bear on these problems.

To understand how economic analysis might improve decision-making for relevant NOAA Fisheries issues, we use a case study approach to develop our recommendations. We selected six case studies that represent a range of activities being addressed by NOAA Fisheries Habitat Protection Division. We examined these case studies to determine how economics could be used to improve the decision-making process, and we used our assessments of each case study to develop more general recommendations.

The report is organized by beginning with a discussion of the fundamental relationship between fisheries habitat and economics, including discussions of the value of habitat and the major issues of risk and cumulative effects. The next section provides an overview of how economics fits into the process of habitat management, conservation and preservation related decision making. In Chapter IV, we discuss the limitations on the use of replacement costs as measures of economic value of fisheries habitat. Chapter V describes an economic approach to determining technically and legally defensible mitigation ratios. Chapter VI includes the six case studies, and Chapter VII summarizes the lessons learned through the case studies and presents recommendations and conclusions from the study in.

II. Applying Economics to Habitat Regulations and Decisions

II.A. Economic Concepts Related To fisheries Habitat

There are several important economic concepts that need to be understood regarding fisheries habitat that will help define the role for economics in influencing the aquatic habitat management, conservation and preservation decision making process. These include:

1) fisheries habitat is a valuable "natural" economic asset with potentially many productive outputs and can be valued as such.

2) fisheries habitat is an economic asset that provides productive outputs over long periods of time and the stream of values in each period must be added to produce its total value.

3) fisheries habitat outputs serve as inputs into the production both of "public goods", and "open access" goods, that all have characteristics which imply that the marketplace alone will not provide appropriate economic signals that lead to desired economic outcomes regarding habitat.

4) fisheries habitat, itself, most often occurs in locations that do not have simple property rights and hence the marketplace will not necessarily protect them.

Habitat is an essential input into a fisheries production process that produces commercially or recreationally caught fish that are valued by society. In commercial fisheries the value of the asset's contribution accrues to individuals once the fish are captured and sold. For recreational fishermen, the capture of fish only constitutes part of the derived value of the fishing trip which also includes interacting with nature and engaging in a traditional and pleasant outdoor pastime. Habitat that supports forage fish or other ecosystem components that subsequently are linked to the health of commercially or recreationally popular fish populations is also a valuable input. Society may also value marine species that are not captured such as manatees, whales and other marine mammals, and thus, the habitats that support them have value. For these latter species, both use values entailing whale-watching and other types of interactions, as well as existence and non-use values may apply.

If the quantity or quality of fisheries habitat changes, there is usually a corresponding change in the net value of the commercial or recreational fisheries and "non-use" values associated with fisheries. This change in value of the asset may be the result of a change in abundance, availability, catchability, size, geographic distribution or some other quality of the fish population. The change in value of harvested fish caused by the habitat change can then be used to infer the change in the value of the habitat. In a world of well functioning markets and well-defined property rights, the owner of fisheries habitat could charge fishermen for the fishery related value it generates. An example of this situation exists in the form of oyster leases where the owner of productive oyster bottom leases it to another for oyster production. Different quality habitats would be valued differently with high quality oyster bottom that produces more or faster growing oysters commanding higher lease rates than lower quality bottom.

The fact that habitats can remain productive for long periods of time means that the values generated over time must be added up in order to calculate the total value. Besides the problem of determining the contribution of the habitat in each time period, the different values must be adjusted for how far into the future they occur. The typical practice of creating a "present" value requires determining an appropriate social interest rate. This makes the analysis more complicated but the approach does account for time preferences. It is particularly troublesome for changes that occur between generations, for the preferences of future generation are quite unknown.

Most fish habitat, however, is not a simple privately owned asset. Unlike the oyster bottom example above, there generally is no single owner to charge fishermen a lease rate for the fact that fish used that particularly area as a nursery ground or for some other habitat function. When an action is taken that eliminates the habitat or degrades its functions, the cost or lost value is spread among all the recreational and commercial fishermen (and seafood consumers). In effect, NOAA Fisheries in its stewardship role tries to act as the holder of the property right to ensure that the habitat is not lost or degraded. Continuing with the oyster bed analogy, if a marina owner wants to dredge through the oyster bed to allow customers to gain access to his marina, they will have to compensate the owner for the lost lease value. In a real world case, Louisiana oyster lease holders have won (at least for now) compensation due to the diminished value of their leases resulting from a water diversion

Water Diversions and Oyster Bottom Value

In coastal Louisiana, the Caernervon freshwater diversion project was implemented in 1991 to restore freshwater flows from a portion of the Mississippi River to the Breton Sound area near its mouth. The diversion restores the area to a more natural (i.e., lower), salinity regime. Unfortunately for many oyster lease holders, the lower salinity and increased sedimentation from the diversion has made their leases unproductive. The leaseholders filed both federal and state suits to be compensated due to this "takings". While the legal components of this case are complex as to whether the leaseholders are entitled to compensation, there is little disputing that the economic losses due to the diversion are great. The leaseholders were not successful in their case in federal court, but were granted compensation by the Louisiana courts. The case is currently under appeal.

In summary, the above economic characteristics of fisheries habitat as inputs to a production process and as public goods are:

1) fisheries habitat has an economic value that corresponds to the extent and quality of the habitat.

2) The value of habitat is not revealed in the market, and NOAA Fisheries acts as an agent that tries to uncover the costs and benefits to society from habitat alterations.

II. B. Economics of Risk and fisheries Habitat

Ecological risk assessment is a fairly well-developed field of inquiry and its components should play a role in NOAA Fisheries habitat-related activities.[1] In our examination of six case studies, we found that there was both a lack of both site-specific data and of general predictive models that would allow a precise estimate of the impacts of habitat alteration on fish populations. None of the documentation on the case studies provided included a risk assessment of the issue.

If data is available, economics can be built into an ecological risk assessment to provide NOAA Fisheries and others with a better understanding of the relative consequences of habitat alteration. Typically, the economic analysis would take the results from the ecological risk assessment as an input to an economic risk assessment.[2]

In addition to the typical role of risk assessment, there is another component to risk that is important to NOAA Fisheries' role in habitat protection issues. This additional economic component is relevant if one believes that NOAA Fisheries is representing a society that is risk averse towards alterations in marine habitat or the quality of the environment in general. Risk aversion is the characteristic that an individual or representative group prefers an outcome with certainty to an uncertain outcome that has an expected value equal to that certain outcome. Suppose we know that the net benefit from fishing with the current habitat conditions in the region is a $1,000 for a fisherman. Now a proposed alteration to the habitat in the area has a 50% probability of reducing his income to zero and a 50% probability of increasing the fishing income to $2,000. The expected value of the habitat alteration (.5X$2,000+.5X$0 = $1,000) is the same as the certain income of $1,000, but the risk averse individual will prefer the certain income. They will prefer the uncertain outcome if the expected value is greater than $1,000. The risk premium is the amount more than the certain amount they would have to be calculated, and the magnitude of the risk premium will depend on the individual's degree of risk aversion.

The risk aversion issue can play an important role in both measuring the economic harm from habitat alteration and the proposed mitigation. In Section V, we discuss how mitigation ratios should incorporate risk regarding the effectiveness of mitigation in the calculation. However, even when mitigation is not part of the issue, habitat alterations that increase risk impose a cost on society that is often not considered in the deliberations.

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[1] See for example EPA website on risk assessment at http://www.epa.gov/ncea/ecologic.htm, or various issues of the journal Human and Ecological Risk Assessment (Amherst Publishers).

[2] A crude approach to economic risk related to recreational values of fish might be to offer a low and high estimate of the value.

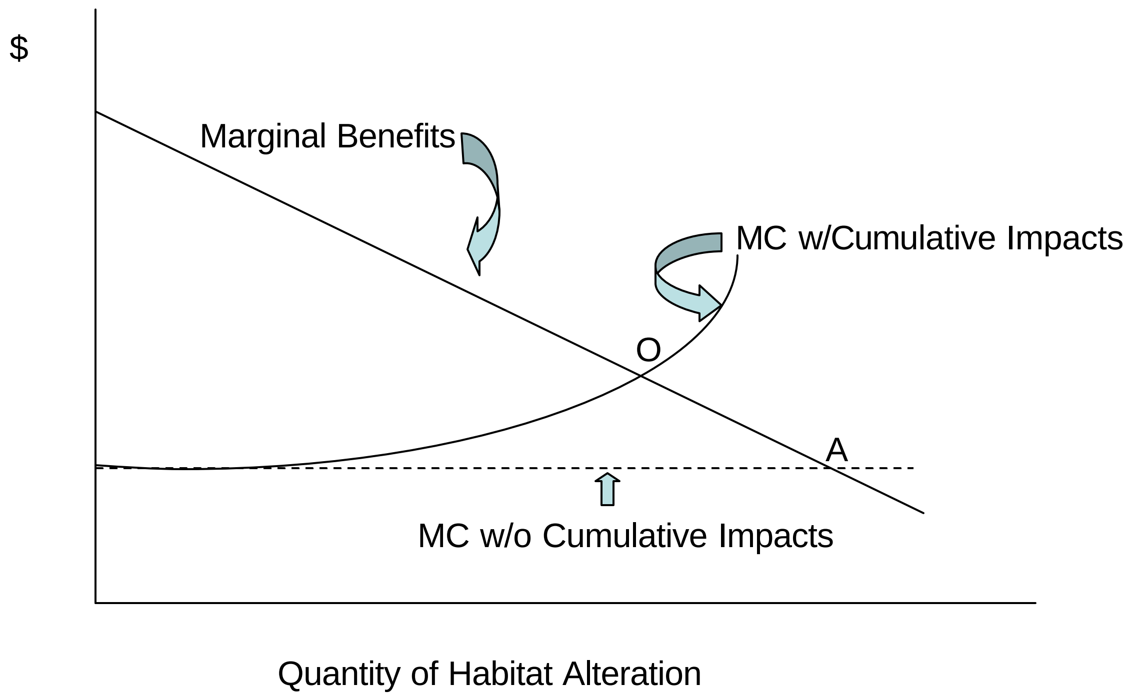
II. C. Economics and Cumulative Effects

From an ecological perspective, NOAA Fisheries has expressed concern about the cumulative effects of habitat alteration on the health of fish populations. This is because when the same impacts are attributed to all similar sized projects, the project-by-project evaluation process makes it difficult to implement a policy that protects against harm from the sum of those impacts, especially when there is uncertainly involved regarding the impacts. Here we interpret the term cumulative impact to refer to the situation where the marginal effect of habitat alteration is increasing with the total amount of alteration that takes place -- the impact of the 100th acre of habitat that is destroyed is greater than the impact of the 1st acre.

In economic terms, there is a marginal cost to society from habitat alterations and knowing the shape of that cost curve is fundamental to implementing a meaningful strategy that protects against harm from cumulative impacts. Figure 1 shows a stylized marginal cost curve for habitat alteration. The part of the curve closest to the origin can sometimes be depicted as downward sloping, allowing for the possibility that initially habitat alterations may have decreasing marginal costs to society. One explanation for this possibility is the "edge effect" where destruction of some habitat actually increases the availability of some positive aspect of the habitat that contributes to productivity of fish. In economic production, this declining marginal cost represents increasing returns to scale and it is always more profitable for the firm to produce more when marginal costs are declining (providing it is profitable to produce any amount). The relevant part of the curve for our discussion is when it is curving upward, the diminishing returns to scale section.

Two marginal cost curves are shown in Figure 1. The dashed line corresponds to the assumption that each additional quantity of habitat alteration has the same marginal cost to society, regardless of how much alteration has preceded it. The solid marginal cost curve diverges from this assumption so that at some point the additional habitat alteration has higher costs than preceding alterations. This point of increasing marginal costs can happen smoothly as depicted in the graph or there can be a discreet jump at some threshold level. This increasing cost might be due to the crash of an important recreational or commercial fishery due to loss of habitat. Figure 1 also includes a downward sloping marginal benefits curve that represents the benefits to society external to the fishery that might accrue from habitat alteration (e.g., the benefits of dredging for a marina). The optimal habitat policy is to allow alteration of habitat until the marginal cost to society from that alteration equals the marginal benefit, point O on the graph. The problem is that if we do not allow for cumulative impacts, we act as if the marginal cost curve is the dashed line, and allow increased habitat alteration until we reach point A where the marginal benefits equal the marginal costs without cumulative impacts. At this point, we have allowed a level of habitat alteration where the marginal costs are significantly greater than the marginal benefits.

Figure 1. Marginal costs and benefits of habitat alteration.



The challenge is to know where the point of cumulative impacts accelerates and to allow habitat alteration only up to a safe distance away. Our data and experience are usually in the flat portion of the curve, which leads us to predict that the next project will always have the same small impact as the previous project. The two most obvious ways to predict where cumulative effects will have an impact is to either base it on real world circumstances or on some form of mathematical model. Finally, there is an important link between cumulative impacts and risk as discussed in the previous section. Since we often do not know the threshold level at which marginal costs increase significantly, each new project involving habitat alteration moves us closer to the threshold and imposes increasing risks on a risk averse society.

It must be emphasized the NOAA Fisheries in most instances will not be the primary Federal or even state agency making the decision regarding habitat change. Federal agencies such as the Army Corps of Engineers, the Environmental Protection Agency, the Department of Interior or the Department of Energy often have the primary responsibility for doing the regulatory analysis of the entire project, of which the habitat change relevant to fisheries may be only a small fraction. NOAA Fisheries will have a role to assure that the habitat change is costed (valued) in a reasonable manner and to raise question regarding the costs of alternatives (with reduced habitat impacts) to the proposal. NOAA Fisheries will want to assure that the other agencies are following the guidelines for regulatory analysis (e.g. benefit/cost

analysis) set forth by the Office of Management and Budget (see for example OMB, "Draft 2003 Report to Congress on the Costs and Benefits of Federal Regulations", Federal Register/Vol.68, No. 22,54925527, February 3, 2003).

II.D. Measuring Benefits and Costs: Economic Tools

What tools are available to economists to measure the benefits and costs of habitat degradation or loss? Without the market price for habitat as in the oyster lease bottom example, there is not a market that habitat is bought and sold in to observe its price at various quantities. The non-market nature of fisheries habitat requires the application of economic tools that have been developed to determine the value of non-market goods and services. Overviews of these tools such as random utility models, hedonic models and contingent valuation are readily available, and therefore are not reproduced here. The reader is referred to the following sources that have been developed specifically for the non-economist:

Lipton, D.W., K.F. Wellman, I.C. Sheifer and R.F. Weiher. Economic Valuation of Natural Resources: A Handbook for Coastal Policymakers. NOAA Coastal Ocean Program Decision Analysis Series No. 5. 131pp. 1995.. also available for download at: http://www.mdsg.umd.edu/Extension/valuation/handbook.htm

Letson, D. and J.W. Milon (editors). Florida Coastal Environmental Resources: A Guide to Economic Valuation and Impact Analysis. Florida Sea Grant College Program. 229pp. 2002.

U.S. Environmental Protection Agency. Case Study Analysis for the Proposed Section 316(b) Phase II Existing Facilities Rule. Chapter 9. Economic Benefit Categories and Valuation Methods. Office of Water EPA-821-R-02-002. 2002. http://www.epa.gov/waterscience/316b/casestudy/cha9.pdf

III. Economics and the Decision Process of Habitat Protection

III.A. The Decision Framework

At a general level there are several types of economic analysis that can provide useful information for decision-makers dealing with habitat alteration. Some of these methods actually involve the use of environmental values as part of the analysis. Information generated from these analyses can help frame the tradeoffs inherent in proposed projects and activities and their potential environmental harm. For example, in selecting among different options designed to minimize the impacts of dredging, decision makers may need to understand the relative costs and benefits of different proposals and the wider economic impacts that may result. The three analytical tools most widely used by economists are:

1) Benefit-Costs Analysis – a tool that provides a quantitative method for comparing the economic benefits and costs associated with a specific project. Environmental values are often part of a comprehensive benefit-cost analysis.

2) Economic Impact Analysis – an approach that allows one to assess how the direct impact of expenditures of a project will ripple through the local economy and affect regional employment and income.

3) Cost-effectiveness Analysis – a technique used to rank the project alternatives that achieve a similar or predetermined outcome. The alternative that achieves the outcome at the least cost is deemed most cost-effective.

The decision to pursue one or more of these approaches will depend on what information is needed to support policy decisions and the resources available for conducting economic studies. (For a more detailed outline and set of examples of these general approaches please see Wellman, 2001)

III.B. A Structured Decision Approach to Habitat Management, Conservation and Preservation

As discussed above, the economic component of risk in NOAA Fisheries habitat-related decision making may be significant and should be included in the characterization of the benefits and costs of projects impacting aquatic habitats. However, as indicated in Understanding Risk (NRC, 1996) there are limitations to the techniques available for risk analysis and fundamental and continuing uncertainty in information about risks. The NRC report indicates that risk characterization involves complex, value-laden judgments and requires effective dialogue between technical experts and interested and affected citizens, who may lack technical expertise, yet have essential information and often hold strong views and substantial power. The report goes on to outline an iterative analytical-deliberative process that they feel can improve risk characterization, informing decisions, and making those decisions more acceptable to interested and affected parties. It suggests that "the technical and analytical aspects of risk analysis must be balanced with a concern for appropriate involvement by interested and affected parties in all steps of the decision-making process, including those leading to risk characterization. Analysis and citizen involvement are not separate steps to be carried out in sequence, but must be combined into an effective synthesis" (NRC, 1996).

In this light there has been a recent push towards developing structured decision approaches which reflect the basic conceptual thinking presented in NRC (1996) about the characterization of risks, costs and benefits and involvement of resource stakeholders. It supplements the economic assessment techniques mentioned above with other methods, such as focus groups, designed to assess broad ranges of expert and public perceptions and values and identify and quantify tradeoffs. The fundamental tasks of a structured decision approach include:

- Defining the decision problem to solve the right issue. This task may be viewed as clarifying what one is really trying to achieve with the decision. What are the main aspects of a decision situation? What is a reasonable goal of the consultation process?

- Defining key objectives. How do people think they will be affected by some proposed action? What values matter most to stakeholders?

- Creating better alternatives to choose from. In light of all relevant constraints, what are the alternative actions that might be undertaken to meet stated objectives?

- Describing how well each alternative meets the stated objectives. This is essentially the identification of consequences. What are the most important impacts that could affect stated objectives and how certain are you that they will occur?

- Balancing objectives when they cannot all be achieved at once (clarifying tradeoffs). What are the important conflicts between objectives, and how can this knowledge be used to create new and better alternatives?

- Identifying and quantifying the major uncertainties affecting the decision.

- Counting for tolerance for risk.

- Planning ahead by coordinating current and future decision (linking decisions)

The root idea of a structured decision approach to public involvement reflects common sense and good judgment. However, the application of a structured approach emphasizes qualitative guidance for how to think clearly and make smart choices rather than quantitative analysis to make an optimum decision (the focus of most B/C analysis). It goes beyond classical economic approaches by identifying tradeoffs and offering an opportunity to learn a great deal about individual and social objectives, how these objectives link to acceptable actions and the fundamental rational for the tradeoffs expressed. In addition, the approach leads to a better-informed public and a process that more fully incorporates their views and concerns. It has proved to be an effective decision-making tool in a number of settings (Gregory, R. and Wellman, K.F. 2001, Bringing Stakeholder Values into Environmental Policy Choices: a Community –Based Estuary Case Study. Ecological Economics 39: 37-52).

We do not foresee NOAA Fisheries applying the Structured Decision Approach as a routine component of their habitat-related activities, but rather becoming an advocate for its application in a broader policy framework.

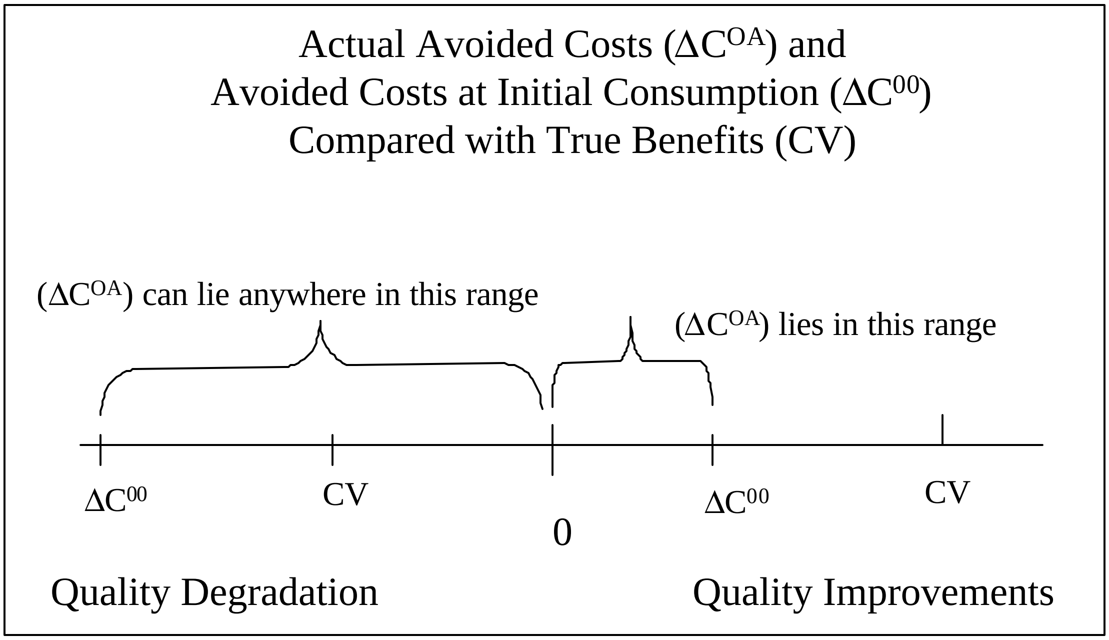
IV. Using (Replacement) Costs as Economic Value

IV.A. Background

There are times when changes in costs are viewed as the entire benefit or economic value from a project. . It is common practice in benefit-cost analysis to consider minor costs savings from initial expenditures as a benefit of a project. However in some instances, the savings in costs are claimed to be the entire benefit of a project.[3] Because the expansion of this procedure seems inherently incorrect, we now take time to examine when a typical essential fish habitat project might claim changes in costs as its benefits as well as the assumptions, approximations, and potential dangers of doing this.

But when do changes in input expenditures provide an exact measure of the entire benefits from a project? The answer is that they seldom will provide an exact benefit measure but will provide in some instances an upper or lower bound of the entire benefit. Let us illustrate for the case where a household is incurring costs (defensive or mitigating expenditures) to produce drinkable water. If a project were to improve water quality for the household and reduce the need for household to filter water, then the changes in filtering costs (defensive expenditures) may represent an upper or lower bound on the benefits from improving the water quality. But when do they represent the entire amount? The first challenge in answering this question is choosing at what resulting level of output the new filtering costs should be calculated. Two obvious choices are the original consumption of water (call it OO) and the actual consumption of water after the change (call it OA). If we were to know what the household would be willing to pay to have project's clean water available to it (call it CV), then we can compare the true benefits (that is, CV) with the changes in defensive expenditures at the original consumption level (?C^{OO}) and for the actual change in costs (?C^{OA}).

[3] For example, the U.S. EPA has made the claim that one can use habitat replacement costs as the entire benefits from projects that reduce entrainment/impingement and thermal effects from power generating facilities.



Bartik (1988) has derived the relationship among these three values and we portray his results graphically in the box above[4]. Because the relationship among the three depends on whether the project represents an improvement or degradation in quality, two sides of a line are shown. The change, $?C^{OO}$, represents an underestimate of gains from improvement in water quality and an overestimate of losses from degradation. He shows that the actual expenditures are greater underestimates of true benefits for water quality improvements and that the actual cost response is less than the output constrained response ($?\,C^{OA} < ?\,C^{OO}$). However, we do not know if actual cost changes ($?C^{OA}$) are larger or smaller than the true value (CV) for the case of degraded water quality. It is also true that the changes in defensive expenditures are equal to the true benefit when the input (water) has a perfect substitute.

If the project were to improve quality, then the two measures of change in defensive expenditures are lower bounds on benefits. The actual change in defensive costs would be no more than the change in defensive costs at the initial level of consumption. The logic of this ordering is simple: substitution to water consumption can occur when improvement occurs so that the individual may choose to consume more water. Hence, their willingness to pay for the improvements would be more than the decreased defensive expenditures. At the same time, the potential of higher output would mean a potentially smaller decrease in actual defensive expenditures compared with those if output were to be held constant.

There are several important characteristics of the illustrations above. First, individual choice is involved. The household is assumed to make choices so as to maximize their utility. Secondly, the household is assumed to choose the least cost technology. We have information on

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[4] We consider the mitigating or defensive expenditure case because we are interested in the use of replacement costs. One can also consider changes in expenditures associated with essential inputs like travel to a fishing site. We do not consider that case here.

households revealing their preferences and technologies. However, even with these conditions, the relationship between changes in defensive expenditures and true value is tenuous. Bounds are often the best that cost changes afford and with actual expenditure changes with improved quality, there is no relationship between value and the change in costs.

IV.B. Replacement Costs as Avoided Cost /Defensive Expenditures

The cost of replacing lost habitat or the fish themselves is often suggested as a measure of the economic value of the habitat or fish. For example, the American fisheries Society publishes a volume, *Investigation and Valuation of Fish Kills* that uses the replacement cost approach (American fisheries Society, 1992). Replacement costs, as their name implies, are simply the costs of replacing the asset or the services that flow from that asset. Fish habitat is the asset of interest to us and the services it provides include suitable spawning areas and suitable nursery grounds for commercially and recreationally valuable species and their prey. Replacement costs for them include reconstructing wetlands, replacing reefs and restocking with hatchery-reared fish. Replacement costs are the expenditures necessary to provide the same level of services that asset provided before it was lost or impaired.

Replacement costs should not be viewed as anything more than costs, and certainly not economic value, without placing them within a context and making assumptions about the behavior of individuals and society. However, it does seem to be commonplace to use replacement costs interchangeably with value. For example, Kahn, (1998) presents a table entitled "Economic Value of Wetlands" (p. 383) in which the "functional" values of wetlands (benefits) are shown[5]. These "values" are mostly derived from replacement costs. It might be instructive to review how **costs** of actions can end up as **benefits** in any economic analysis. In doing so, hopefully the reasons why they should be used sparingly will become evident.

The leap to using replacement or enhancement costs as the entire value of changes in resources arises when projects cause improvements to resources that are difficult to value. For example, the economic value of enhancing recreational and commercial fish resources as well as forage fish resources is difficult to estimate. The modern methods of random utility models, for example, are often expensive to implement and, in many instances, not reliable based on the data that exist. Forage fish are particularly troublesome to value since the value to humans derives from their capacity to produce other fish and wildlife that society values. One must know not only the value of commercial and recreational fish but also the relationship among forage fishes and commercial and recreational harvests. In an attempt to resolve this problem, researchers assessing a project that improves fish habitat may assume that society would be willing to incur the enhancement costs to have the resources at the improved level. Because society will not have to incur these costs if the project proceeds, the benefit from improvement in fisheries from the project is the avoided enhancement costs. This of course begs the question of why society did not originally have the higher level of resource if it was willing to pay the enhancement costs.

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[5] He does within the text explain the manner in which replacement costs can be construed as economic value but the labeling in the table is not as explicit.

On the other hand, suppose a project will damage resources that have values that are difficult to measure. In this case, the assumption is often made that society will incur the additional costs of replacement for the incremental damages subsequent to the project's implementation. The argument follows that the benefits from not having the project are the avoided replacement costs.

There are many conceptual issues arising when following this logic. To begin, the economic notion of benefits derives from an individual's (producer or consumer) welfare improvement -- that is, individuals obtaining maximum satisfaction and using least costs methods of production. Here, the defensive actions actually occur and if data exists on the defensive actions, the least cost technology is known. Even then, the relationship between changes in cost and benefits is very limited. With the enhancement/replacement cost argument, there is no individual action and data available- everything is based on assumptions regarding collective actions. There are no longer any clearly defined relationships between a willingness to pay and changes in defensive expenditures. The nexus between value and changes is defensive expenditures is completely broken.

IV.C. Defensive Expenditures, Replacement Costs and Essential Fish Habitat

Now let us consider using the cost of replacing an essential fish habitat as a measure of its value. How would one go about justifying this action? Several issues must be considered. First, one might determine what the "average" community facing a loss of essential fish habitat would commit financially to replacing it. One must consider all communities in similar positions and determine the average of expenditures across all of them to obtain a representative "value". There may be 10,000 communities and fish habitats that have not incurred replacement costs. In many, many instances, if we were to consider only the replacement/mitigation/enhancement costs, then we would have to deduce that the local value for the fish habitat is substantially lower than the actual replacement or mitigation costs because the vast majority of communities have chosen not to incur them. In fact, accepting the proposition that a political process reflects benefits greater than costs and then choosing a representative replacement cost (including zeros), one may conclude that the value to communities is nearly 0! Mind you, the actual benefits may not necessarily be zero but the process of considering politically instituted replacement costs to reflect values probably is not defensible.

An alternative might be to receive a commitment that a community would replace the lost habitat and thus reflect its willingness to pay for the habitat. Even with this commitment, the decision to make the expenditure would not usually be incurred by individuals who are comparing their personal benefits with their personal costs but rather through a political process. One might argue that the political process allocates so that benefits are at least as great as the costs and choose a situation (such as a state agency or other government body incurring expenses to prevent damages) to obtain costs. That political choice reflects net social value is the first condition that must be true to do this. Secondly, we must assume that the technology chosen to replace the habitat is the least cost technology. Both of these presumptions are tenuous given human nature and evidence of government graft.

The estimate of replacement and enhancement costs in the case of essential fish habitat likely does not have any close correlation or ability to establish an upper or lower bound on the value of essential fish habitat. We have to conclude that the most defensible approach is to develop values for commercial and recreational fish and also continue to develop models relating essential fishery habitat to fishery resources and forage fish to commercial and recreational fish. If one can estimate f the net value to commercial and recreational production from restoring services of fish habitat, one is in a far superior position to having to use replacement costs. These values should be estimated and the use of replacement/enhancement costs should be used only in extreme circumstances.

IV.D. Avoided Costs of Regulatory Requirements[6]

A situation might arise where the law, not economic behavior, would establish that avoided costs or defensive expenditures are an upper bound on the value of an asset. Damage assessment creates a situation in which replacement costs may play an important role in establishing bounds on value. In damage assessment cases, it is the requirement of law that an individual be made "whole", or in economic terms, returned to their original level of utility. Replacing the asset or services from the asset is clearly a manner in which the individual can be made whole. A 1972 Dodge severely damaged in an accident may be able to be restored only with large expenses, say $30,000. In essence, the replacement of the car in this manner is like the requirement for keeping output constant in section IV.1.
In this case that value could be viewed as representing the upper bound on the value of any action that makes the owner "whole". The individual may be made whole without expending $30,000. That is, the owner may be returned to their initial level of utility by the purchase of 2002 Toyota for $20,000. Thus, the amount of $30,000 only represents an upper bound and is a measure of value only in a very constrained sense.

In the case of fish habitat, the replacement cost valuation would have to be defended on the basis that the law requires the re-establishment of the fish habitat or its services and the determination of the baseline level of the asset or flow of services. This is a complex issue and certainly a complex process to obtain costs. However, the costs should be least costs for restoring the baseline.

The difficulty with calculating avoided costs is determining what is the least cost way to maintain essential fish habitat. That is, there are numerous ways to offset environment change and their cost will vary substantially. Considering the entire range and the least cost estimate is not easy. The uncertainties with determining what is the environmental output from fish habitat alone are staggering. If one is allowed to substitute one species for another or to change the spatial distribution of the species, the trading rates must be determined. This is a fundamental problem that relates back to the manner in which individual's value the species and their location. Chapter V. will deal with some of these issues in more detail.

[6] The Office of Management and Budget's proposed guidelines for regulatory analysis separates changes in defensive expenditures from the avoided cost of regulatory requirements. In this manner, the reason for the use of cost as a value is made more evident.

IV.E. References

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V. **Economic Considerations for Mitigation Ratios**

V.A. Background

The issue of mitigation arose in the discussion for five of the six case studies examined for this study (see sections VI.B., VI.C., VI.E., VI.F. and VI.G.). NOAA Fisheries is frequently asked to make recommendations regarding permit applications for development projects that will adversely impact coastal wetlands and other important fish habitat. Because these wetlands and other habitats may be scarce and valuable and at risk from unavoidable hazards, such as sea level rise and subsidence, NOAA Fisheries often recommends that permits for such projects be denied. However, some economically worthwhile or politically popular development projects cannot be designed to avoid all impacts to coastal habitats and will be permitted, despite NOAA Fisheries objections. Under such circumstances permit conditions will usually require that permitees minimize habitat impacts to the maximum extent "practicable", and mitigate any remaining impacts by undertaking habitat creation, restoration, or enhancement projects. This chapter deals with the criteria that federal and state agencies use to establish the level of mitigation that is adequate compensation for "unavoidable" impacts. Since this approach has been most widely used for mitigation of wetland habitat, we will focus on that here, but the concepts apply to any habitat mitigation project, including mitigation discussed in our case studies chapter.

The evidence is abundant that created and restored wetlands do not always function as well as "natural" wetlands, and that wetland mitigation often fails to fully compensate for the wetland functions and values lost to development. It makes sense, therefore, for NOAA Fisheries to oppose wetland development, even with mitigation. However, when it is clear that a proposed project will reach the mitigation stage of permitting, the only viable strategy for protecting coastal wetlands is to influence how much mitigation is provided and where and how it is provided. Here we illustrate a method, based on conventional economic analysis, for assessing and comparing mitigation alternatives. The method treats each acre of wetlands, not as equally valuable components of nature, but as economic assets that have different values based on the streams of functions and services they are expected to provide over time. The method is based on a conventional “net present value” valuation technique that is used almost universally to compare manufactured assets. The method that is outlined here has also withstood technical and legal challenges as a basis for comparing the value of wetlands and other natural assets.

V.B. The Role of Mitigation Ratios

Under most state and federal wetland regulations the amount of wetland mitigation that is required to offset “unavoidable” wetland impacts is determined using a mitigation ratio (also called a compensation ratio). This ratio is calculated as the number of acres of created, restored or enhanced wetlands required as mitigation for each acre of natural wetland that is impacted, usually based on a Habitat Equivalency Analysis or similar methodology. From an economic perspective these ratios reflect a type of quantity-quality tradeoff. Where two assets of equal value are involved in a trade, they can be fairly traded on a one-for-one basis. Where they are not of equal value some type of quality/quantity adjustment can be used to even out the trade. It is generally understood that the functions and values provided by an acre of created or restored wetland, in most cases, are less than those associated with a natural (impacted) wetland. In principle, the mitigation ratios used to guide wetland mitigation trades are intended to balance gains and losses by requiring more than one acre of wetland mitigation for each acre of wetland impact.

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There are obvious limits to how well a mitigation ratio can balance gains and losses associated with wetland mitigation. Many acres of low-quality wetlands restored in an inferior location, for example, may never provide an “equivalent” amount of functions and values as one acre of high-quality wetland in a particularly important landscape setting. However, if they are established based on reasonable indicators of relative values, compensation ratios can provide a sound basis for determining how much and what type of mitigation should be required.

V.C. An Economic Perspective

Using conventional economic analysis and the standard and universally used net present value formula, wetland mitigation ratios should reflect differences in the relative values of wetland services expected from the impacted wetland and the mitigation wetland, as well as differences in the timing and risks of those services. A project with an 80% chance of fully restoring fishery-related wetland values a mitigation site by year 10, for example, should not have the same “value” as an acre of fish habitat being lost now at the impacted wetland site. The same is true for other wetland functions and values that may be lost immediately at the impacted wetland site and be replaced over time and at some risk at the mitigation site. The formula that is proposed in the next section for establishing technically and legally defensible mitigation ratios takes account of time, risk, and differences in the expected levels of wetland function. Extensions of the formula can be used to reflect the fact that wetland functions provided at different locations (e.g., offsite mitigation) may not provide the same services and values. However, these extensions will not be discussed here.

V.D. Prevailing Wetland Mitigation Ratios

A recent national review of 68 wetland mitigation banks (Brown and Lant, 1999) determined that the mean mitigation ratio used to score wetland mitigation trades was 1.36:1, based on the number of trades, and 1.41:1 when trades were weighted by wetland area. Thus, roughly 1.4 acres are created or restored for each acre of natural wetland destroyed. The review also showed that "the majority of wetland mitigation banks use a 1:1 ratio, accounting for 73% of all the acreage."

A typical compensation ratio of 1:1 for these wetland trades is surprising when one considers that the sample of mitigation projects used in the study had the following characteristics: creation (25%), restoration (49%), enhancement (15%), and preservation (12%)[7]. If one factors in the time it takes for created and restored wetlands to function at full capacity, the riskiness of wetland mitigation, and the fact that providers of mitigation should not receive "credit" for wetland functions that existed at the mitigation site prior to mitigation, one would expect prevailing ratios to be much higher, and to almost never be 1:1. In fact, using the economic approach to establishing mitigation ratios that is described and illustrated below, an approach based on conventional asset valuation, a ratio of 1:1 can only result in "no net loss" of wetland function and value in the unlikely event that proposed mitigation provides full, immediate, and riskless replacement of all wetland services lost at the impact site on an acre-for-acre basis.

As quality standards have developed for wetland mitigation in terms of what is done and how much is spent per acre, the compensation ratio has become the single most important economic parameter in wetland mitigation permitting. The overall cost of mitigation, after all, is calculated as the cost per acre of mitigation multiplied by the number of acres of mitigation required. This means overall mitigation costs rise and fall proportionately with the mitigation ratio. With any given standard of restoration quality a mitigation of 2:1 or 3:1 involves two or three times the cost as mitigation provided on a 1:1 basis. In the absence of a legally defensible basis for establishing any higher mitigation ratios, mitigation ratios of 1:1 or a little higher are strongly supported by mitigation providers and often accepted by wetland regulators. However, these ratios do not usually result in trades that make economic sense. Acres of wetlands is not a useful measure of wetland value and achieving "no net loss" of wetland acres, or even a net gain in wetland acres, is not protecting what people value about wetlands.

One reason that prevailing compensation ratios seem inconsistent with asset-based trading is that wetland scientists have generally viewed all wetlands as valuable, and have resisted political pressure to classify wetlands in ways that suggest that one wetland may be less valuable than another. In the past this may have prevented "low-valued" wetlands from being targeted for development. However, it also provided no technical basis for distinguishing between wetlands for purposes of prioritizing conservation or managing mitigation. As a result, compensation ratios have been based, in most regulatory settings, on political negotiations, rather than science or economics.

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[7] These percentages are taken directly from Brown and Lant (1999) and sum to 101%, presumably because of rounding error.

In some cases such negotiations have resulted in official mitigation ratio tables that are used routinely by regulators and have specific ratios for specific types of mitigation (e.g., 1.2:1 for restoration projects, 2:1 for enhancement projects). Establishing ratios this way is convenient for regulators and permit seekers, but makes it very difficult for environmental scientists to influence the level of wetland mitigation that is required. It also gives lawyers and regulators far too much discretion in establishing the terms of mitigation trades, including who bears the risks of failure. Political leaders, after all, are often interested in calling a mitigation trade a "win-win" solution. In most instances they can if it achieves "no net loss" in terms of acres, that is, a ratio of 1:1. Permit seekers and mitigation providers are more concerned about the cost of mitigation than the expected outcomes, and therefore are in favor of keeping compensation ratios low. they do this most effectively by managing the expectations of regulators and political leaders regarding what mitigation costs and what level of mitigation costs should be considered "excessive." .

V.E. Economic Basis of Mitigation Ratios

The mitigation ratio is supposed to be an aggregate index that reflects differences in wetland value and allows the quantities of wetlands gained and lost as a result of mitigation to adjust for these differences in value. In the case of manufactured capital, the mitigation ratio would be equivalent to the number of shares in a risky start-up company (penny stock) an investor would be willing to accept to give up one share of stock in a stable, mature (blue chip) company. That number depends on the differences in the expected stream of annual benefits over time (annual profits or annual wetland services) and the risks associated with them (the likelihood that the company or wetland will continue to provide benefits over time). These are the factors that should be reflected in wetland mitigation ratios.

V.E.1. Elements of Mitigation Ratios

To account for differences in the value per acre of impacted and replacement wetlands, the mitigation ratio should take account of five factors:

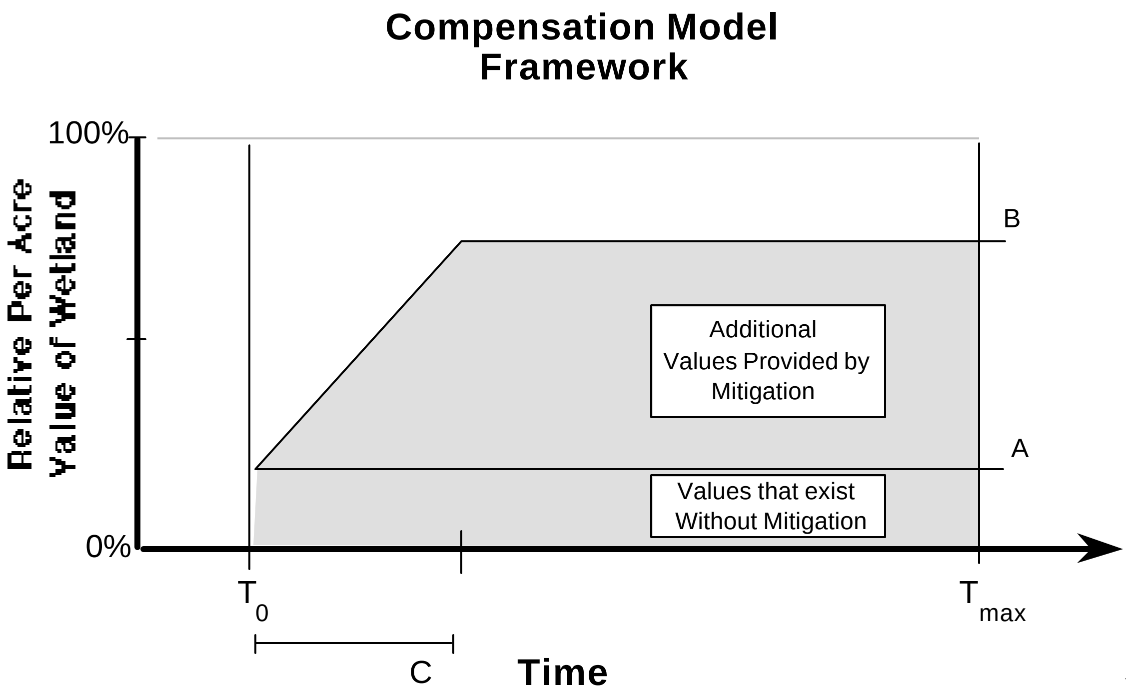
1) The **initial** level of wetland function at the site prior to the mitigation.
2) The **resulting level** of wetland function expected at the mitigation site after the project is fully successful.
3) The **length of time** before the mitigation is expected to be fully successful.
4) The **risk** that the mitigation project may not succeed.
5) Differences in the **location** of the lost wetland and the mitigation wetland that affect the services and values they have the capacity and opportunity to generate.

V.E.2 The Framework

The framework that is developed here does not address issues related to differences in the location of wetlands, item (5) above. In other words, the framework assumes that wetlands that provide the same level of function at any site (e.g., nutrient trapping) will provide the same services (e.g., water quality improvements) and that these services will obtain the same physical improvement (e.g. result in the same improvements in fishing) in locations where they are in equal demand (e.g., where fish or fishermen are just as abundant or scarce).

Using the rest of the factors listed above, a preliminary formula for computing a compensation ratio is depicted in Figure 1. Destruction of the original wetland (at time labeled T_0 in Figure 1) leads to a loss of 100% of its value as the expected streams of services stop immediately. Another wetland is created, enhanced, or restored to compensate for the loss of wetland functions at the impact site. The replacement value of the mitigation site climbs gradually over a period of C years from level A—the value provided by the mitigation site prior to the mitigation project—to some maximum level, level B. To maintain a clear basis of comparison both A and B are expressed here as a percent of the per acre value of the impacted wetland. The maximum level of replacement value reached at the mitigation site (B) will typically be less than 100% of the value lost at the impact wetland. However, that may not always be the case. If the original wetland was seriously degraded before the impact, the value of B at the mitigation site, which is expressed as a % of the function at the original site, could be greater than 100%. Note that the value of A, which reflects wetland values at the mitigation site prior to mitigation, is assumed to be zero for wetland creation projects, low for restoration projects, and high for enhancement projects.

The total magnitude of the loss of wetland value caused by destruction of the original wetland is represented by the entire area under the 100% line from T_0, the time of destruction of the original wetland, to T_{max}, the time horizon selected for the analysis, say 40 years. The total magnitude of the gain in wetland value resulting from the mitigation is depicted by the shaded area above the line at A. The line at A represents wetland values at the mitigation site even without the mitigation which do not contribute to the "scoring" of mitigation. The shaded area above A represents the increase in wetland value due to the mitigation.



FigFig

ure 1: A Simple Wetlands Compensation Model

V.E.2.a. Necessary Conditions for 1:1 Mitigation

Using the above model consider the conditions under which a mitigation ratio of 1:1 would provide "no net loss" in the economic value of wetlands. Ignoring the potential risks of mitigation project failure, this ratio would require that three conditions be met.

1) The mitigation site produces wetland value sufficient to replace the value of the lost original wetland (B=100% or more),

2) The mitigation site generates those maximum wetland values as soon as it is constructed (C=0), and

3) Wetland values at the mitigation site in the absence of the mitigation activity are negligible (A˜0).

Such a scenario is highly unlikely. In fact, considering the fact that few mitigation projects involve wetland creation (A=0), and most require years to succeed (C>0) and never fully succeed at replacing lost functions and values (B<0), the situations where a ratio of 1:1 can be justified are indeed rare.

V.E.2.b. More Typical Mitigation Conditions

Generally, wetland projects take years to replace the level of function provided by the impacted wetland (C>0), and often that level of function is not as great as the level lost at the impact site (B<0). As a practical matter most wetland losses cannot be compensated fully using a mitigation ratio of 1:1. In Figure 1, the white area above the line at B and below the 100% line depicts one component of wetland value that is not compensated. The shaded area below the line at A depicts another area of uncompensated wetland value, i.e., wetland functions not attributable to the mitigation effort.

The framework depicted in Figure 1 for displaying wetland function losses with 1:1 mitigation is relatively simple to apply because the percentage loss in wetland value with acre-for-acre mitigation depends directly on the values of A, B and C. These, in turn, can be determined directly from the level of function at the impacted wetland site and the characteristics of the mitigation site and the mitigation project. The appropriate mitigation ratio is the number of acres of mitigation required to generate "no net loss" in the value of the stream of wetland services gained and lost over time based on A, B, and C. The following section illustrates how to calculate that ratio.

V.F. The Compensation Formula

Since the cross-hatched area in Figure 1 depicts the value provided by an acre of mitigation, and the entire rectangle from T_0 to T_{max} depicts the values lost with each acre of the lost wetland, dividing the cross-hatched area by the total area gives the percentage loss of wetland value with 1:1 mitigation. The inverse of this percentage gives an estimate of the "appropriate" compensation ratio. A 50% loss on an acre-for-acre basis requires a mitigation ratio of 2:1, a 33.3% loss requires a mitigation ratio of 1.5:1, a 66.6% loss requires a mitigation ratio of 3:1, and so on.[8]

However, this simple formula misses a few important considerations -- the timing and risk of compensatory mitigation. A more thorough version requires accounting for three additional factors, including:

1) *Advanced or delayed compensation*—the possibility that a mitigation project may be completed and begin providing replacement wetland value either before or after the loss of the original wetland,

2) *Time discounting*—to account for the fact that wetland functions replaced in future years do not provide the same value, measured in present value terms, as wetland functions lost today, and

[8] It is important to remember that we are referring to the economic value of the wetland service, and not some biologically-based measure of wetland value such as in a Habitat Evaluation Procedure.

3) *Risk*—that a wetland creation or restoration project will not perform as well as expected.

These refinements can be made by introducing into the compensation ratio formula a few new parameters that characterize when the mitigation is provided and the risk that the mitigation will fail. The formula then becomes a relatively standard version of the universally used "net present value" formula which is used to evaluate all types of investments and asset trades. The problem of monetary valuation is avoided because we are comparing the streams of values in relative terms using the values provided at the impact site as 100%.

Using the formula requires the user to estimate or somehow settle upon (through literature review, on-site studies, expert opinion, etc.)acceptable values of the following parameters:

A: The level of wetland function provided per acre at the mitigation site prior to the mitigation project, expressed as a percentage of the value of the original wetland.

B: The maximum level of wetland function that each acre of successful mitigation is expected to attain, if it is successful, expressed as a percent of the per acre value of the original wetland.

C: The number of years after construction that the mitigation project is expected to achieve maximum function.

D: The number of years before the destruction of the original wetland that the mitigation project begins to generate mitigation values (negative values represent delayed compensation).

E: The percent likelihood that the mitigation project will fail and provide none of the anticipated benefits (with mitigation failure, wetland values at the mitigation site return to level A).

r: The discount rate used for comparing values that accrue at different times at their present value. (Tables provide estimates based on discount rates of 0%, 5%, and 10%.)

T_{max}: The time horizon used in the analysis. (Using the OMB-recommended discount rate of r=7%, comparisons of value beyond about t=75 years are of negligible significance.)

Under the circumstances described above the equation that can be used to solve for the appropriate mitigation ratio (ignoring differences in relative values based on wetland location) is as follows:

Discrete Time Equation

$$R = \frac{C\sum_{t=0}^{T_{\max}}(1+r)^{-t}}{(B-A)\left[\sum_{t=-D}^{C-D}\left[(t+D)(1+r)^{-t}\right] + C\sum_{(C-D)+1}^{T_{\max}}(1+r)^{-t}\right]}$$

V.G. Some Illustrations

Table 1 presents some calculated compensation ratios based on the compensation formula. The first three cases show the effects on the resulting compensation ratio of delaying or advancing the compensatory mitigation project. The next three examples illustrate how preexisting wetland values at the mitigation site, or compensation for the loss of a degraded wetland, affect compensation requirements. The final set of examples illustrates how the assessment of failure risk can affect compensation ratios.

The characteristics of the mitigation project itself, as reflected in the values of A, B, and C, are obviously important in determining the appropriate compensation ratio. The last example shown in Table 1, however, illustrates why advanced mitigation should provide a significant advantage over concurrent mitigation in terms of compensation requirements. Since many mitigation failures can (1) be detected, and (2) be corrected within a year or so of project construction, advanced compensation allows mitigation providers to manage many controllable risk factors and significantly lower the risk of failure. At the same time, advanced mitigation provides replacement wetland values sooner than concurrent mitigation, so there is less discounting of replacement values and more resulting mitigation provided per acre. Combined, these factors result in a substantial advantage for advanced as compared to concurrent mitigation in terms of the number of mitigation acres required. Lower compensation ratios for advanced mitigation mean lower mitigation costs, which in many cases could more than offset the cost of committing funds for advanced mitigation or investing in a mitigation bank.

Table 1. Calculated compensation ratios for a variety of hypothetical compensation scenarios, based on a time horizon (T_{max}) of 100 years.

	Parameters					COMPENSATION RATIOS Discount Rate		
	A	B	C	D	E	0%	5%	10%
Concurrent Creation	0	0.7	10	0	0	1.5	1.9	2.3
Advanced Creation	0	0.7	10	5	0	1.4	1.5	1.4
Delayed Creation	0	0.7	10	-5	0	1.6	2.4	3.7
Concurrent Restoration	0.1	0.7	10	0	0	1.8	2.2	2.7
Original Wetland Degraded	0	1.4	10	0	0	0.8	0.9	1.2
Concurrent Enhancement	0.5	0.7	10	0	0.2	6.6	8.1	10.2
Difficult Creation	0	0.7	10	0	0.5	3.0	3.7	4.7
Very Difficult Creation	0	0.7	10	0	0.75	6.0	7.4	9.3
Same, Advanced and Risk Adjusted	0	0.7	10	5	0.2	1.8	1.8	1.8

V.H. Summary

The framework and formula described above are based on generally accepted economic concepts. However, the parameters used to estimate compensation ratios related to any particular project (e.g., A, B, and C) are based on wetland science, or at least the judgment of wetland scientists. It is useful to note that employing the formula allows mitigation providers the option of providing more mitigation by investing at either the intensive or extensive margin. For example, if the mitigation provider spends more per acre to increase the quality per acre of mitigation provided (e.g., higher B, lower C, or both), the mitigation ratio that reflects the number of acres required will decline. If the mitigation provider spends more on land (acres) and less on restoration efforts ($ per acre), the mitigation value per unit area will be lower and the required mitigation ratio (number of acres) will increase.

The proposed formula can serve three purposes. It can help prevent wetland mitigation trades that result in losses of wetland values and impose risks on the general public. It can make mitigation requirements more predictable and consistent for permit seekers. And, it can help mitigation providers understand the payoff from investing in wetland mitigation credits at the intensive margin (more $ per acre) or at the extensive margin (more acres). It also allows the level of wetland mitigation to be based on science and economics, not politics, and generates compensation ratios that will withstand most technical and legal challenges.

VI. Case Studies

VI.A. Case Study Approach

The purpose of examining case studies of recent NOAA Fisheries Habitat Conservation actions is to determine how economics could have been used to improve the decisions made. With the help of NOAA Fisheries staff we selected several different types of case studies that reflect the scale and scope of NOAA Fisheries activities that might benefit from improved economic analysis.

The case study descriptions are not intended to be comprehensive, but do cover details that are relevant to improved economic analysis. For additional information the reader can refer to the source materials that are on file for each case study. The case studies provide a realistic context for illustrating the valid role that economics needs to play to be useful to NOAA Fisheries. While examining the materials that were provided to us we tried to identify the underlying economic issues that were involved, and determine what economic analysis would be most suitable under apparent time and budget constraints. In most cases, however, the economic issues involved in the case studies were not apparent from the available documents and our goal was to bring them into the light of day.

VI.B. Case Study 1 - OENJ Cherokee Corporation

VI.B.1 Description of Action/Issue

The OENJ Cherokee Corporation applied to the Army Corps of Engineers for a permit to authorize dredging of 7.4 acres of mudflat and shallow water habitat to 12 feet below mean low water, install rip rap, a headwall and discharge pipe, construct piers and floats and permanently moor a barge to support a 38-40 slip marina and ferry terminal. OENJ acquired a 166-acre brownfield site in 1992 and has been developing it in phases. This action affects the waterfront parcel. One of the four other parcels of the property has been developed into a mall.

The area to be dredged as well as the surrounding area contains highly contaminated sediments including PCBs and heavy metals. The dredge material will be disposed of at permitted upland sites.

OENJ contended, and for the most part the Corps of Engineers agreed, that the area to be dredged is not valuable fish habitat and that although the mudflat habitat will be lost, the habitat that will result in its place is just as valuable, if not more valuable than the existing habitat. Additionally, the riprap and structures will provide additional new habitat.

NOAA Fisheries contended that even though the area is heavily polluted, the mudflats do constitute important fish habitat providing refuge and forage for a number of commercially and recreationally important species.

NOAA Fisheries major objection was that no mitigation was proposed for the loss of the 7.4 acres of mudflat and shallow-water habitat. Because of the disagreement between the Corps of Engineers findings and NOAA Fisheries, NOAA Fisheries requested that this action be the subject of an "elevation". The original Corps findings were upheld in the elevation process and the permit was granted without the mitigation requested by NOAA Fisheries.

VI.B.2. Economic Issues Considered

Because of the nature of this action, involving a highly polluted estuary, economic arguments were not a major part of the discussion among any of the parties. The situation might have been different if the area in question was an important recreational or commercial fishing ground. However, in a memo addressed to the Federal Regulatory Agencies dated January 20, 2000, OENJ stated:

> "We have maintained throughout the permitting process that the **economic benefits of the proposed ferry service far outweigh any environmental impacts** occasioned by dredging a small area of Newark Bay"

VI.B.3. Evaluation of Economic Arguments Used

The only explicit economic argument used is from the quote above by OENJ that this action clearly passes any benefit-cost analysis that it might be subject to. We agree that it is highly likely in this case that if a comprehensive benefit-cost analysis were conducted, it would result in benefits exceeding costs. The benefits would include the private return on investment that OENJ and others would achieve from this development, as well as consumer benefits generated by the convenience of the ferry terminal and related activities. The costs of the project would include OENJ's development costs, dredging costs and the public costs of the net lost value of the habitat as suggested by NOAA Fisheries.

The fact that benefits might exceed costs in this situation is not a sufficient reason for the Corps of Engineers to allow the project to proceed without the mitigation recommended by NOAA Fisheries. Benefit-cost analyses enable the comparison of feasible alternatives such as including mitigation of the detrimental effects of the project. The cost of mitigation would be included on the cost side of the benefit-cost ledger, but the expected benefits from such mitigation would be added to the benefits side. NOAA Fisheries argument then, is that the project has a higher net benefit when mitigation is included. OENJ, as might any private entity, resists the mitigation because they must bear the costs privately, reducing their return on investment, and the benefits from the mitigation are public goods that cannot be captured by OENJ.

VI.B.4. Economic Issues Not Considered

Implicit in the benefit-cost discussion above, and underlying the basic argument comparing the value of mudflats to the newly created habitat resulting from the dredging operation, is the relative economic value of the habitats being traded off. OENJ is arguing, and apparently the Army Corps of Engineers agreed, that the habitat being created is at least as valuable as the habitat it is replacing. NOAA Fisheries is essentially arguing that society is not being compensated fully for the lost mudflats and that only through mitigation is the public restored to its original level of well-being.

For either side to justify their case would require an ability to quantify changes in commercial or recreational fish populations that would result from a change in habitat. Significant changes in fish populations would lead to changes in catch rates to commercial or recreational fishermen that could then be quantified in economic terms using standard economic models or published literature values attributed to catch rate changes.[9] However, unless the lost habitat was a major spawning area or concentrating area for fish or their forage, it is unlikely that the effect of habitat conversion could be detected or measured on the fish populations.

In addition to changes in fish populations there may be other benefits or costs associated with the existing habitat and its conversion. Although these would not be the focus of NOAA Fisheries concerns, these should be considered in the benefit-cost discussion. For example, some discussion in this case arose regarding the value of the habitat for wading birds, seabirds and waterfowl. Changes that affect the populations of these species as well as their presence or absence in a particular area, in addition to having potential ecosystem effects, could effect the economic value of these resources to birdwatchers and other wildlife viewers.

VI.B.5. Improving the Decision Making Process With Economics

The argument as to whether or not the existing mudflats are more or less valuable than the habitat to be created by the OENJ project is not demonstrable given the existing data, and barring some major breakthrough in ecosystem modeling at small scales, will not be measurable in the foreseeable future. The appropriate question to ask, then, is how to act when such data is lacking. NOAA Fisheries could have made a more powerful argument by placing the discussion in a risk framework.

The risk argument from an economic perspective is as follows. The current mudflat habitat has a positive value that we cannot quantify at this time. The dredging operation will result in first a period of disruption during which this habitat value will be significantly diminished. After an unknown recovery period during which the habitat will have no value as a mudflat and diminished value in its new form, the newly created habitat will eventually have a positive value that also cannot be quantified. Although it is possible that the value of the newly

[9] See, for example, McConnell and Strand (1994) where they estimate that an increase in the historic average catch rate of New Jersey anglers by 0.5 fish per trip results in a net economic gain over the July/August period of $465,000 to $1.2 million, depending on the calculation method used.

created habitat will have a value greater than the lost value of mudflats and the lost value during the recovery period, the entire risk that this will occur is placed on the public sector, and OENJ bears none of the risk. Note that if the public sector is risk-averse (i.e., a risk free outcome is preferred to the same outcome that is uncertain), even if the two habitats are of equal value, the public loses if the project is allowed to go forward without mitigation.

VI.B.6. Generality

The economic analysis of this case can easily be applied to other small scale dredging projects and could lead to improved decisions. The fact that these actions took place in a highly polluted area does not diminish their generality. If the area was not so polluted and were a major fishing grounds for either recreational or commercial fishermen, the impacts would have been more direct and would have strengthened NOAA Fisheries case. However, it is probably more often the case that these types of dredging projects are physically displaced from the fishing grounds making it more difficult to quantify impacts on fishing catch rates. The risk argument used above can also be universally applied, but its relevance grows in importance inversely with our ability to predict how the ecosystem will respond to proposed actions.

VI.C. Case Study 2 - Golden Anchor Dredge and Dock Project, Bar Harbor, Maine

VI.C.1. Description of Action/Issue

In November 1998 Ocean Properties submitted a proposal to the U.S. Army Corps of Engineers for a Maine Department of Environmental Protection Natural Resources Protection Act Permit. The project includes the dredging of approximately 68,439 sq. ft. adjacent to their hotel complex (Golden Anchor Inn and Pier) in Bar Harbor, Maine. Dredged material would be disposed of just southwest of Tupper's Ledge in Union River Bay. The applicant also proposes to install an additional, 10 ft. x 226-ft. line of seasonal docking floats with three perpendicular lines of floats to an existing 125.5 ft. line of seasonal docking floats and be secured by mooring blocks and chain.

The applicant's rationale for the project is that due to increased tourism and related increases in boating traffic to the Bar Harbor area, the marine facilities at the Golden Anchor, LLC are inadequate to handle future docking needs. Ocean Properties suggests that an increase in cruise ship visits and possible ferry service in Bar Harbor are in the future plans of the Town and Maine Department of Transportation. In addition, larger yachts are visiting the Bar Harbor area in greater number and frequency each year. To keep pace with this increased demand for marine facilities, Ocean Properties proposes to increase docking space that is accessible to pleasure boats, boat tours (e.g. whale watching boats), larger yachts, and cruise ship and ferry boat taxis. They feel that the expansion is consistent with the overall plans of the Town of Bar Harbor to increase marine capacity as indicated in the Town's Harbor Management Plan (Appledore Engineering Inc., 1996). According to the plan, it was projected that approximately 3 million people would visit the area in the 1996 tourist season, which reflects a "growing trend".

Cruise ship visits have doubled in the past 2 to 3 years to 56 visits estimated in 2001. The report stated that "[the] town pier and downtown waterfront area can be very congested" and water dependent "facilities [are] too limited to handle" the current boat and related traffic. One solution to this problem is to "improve and expand, where appropriate, existing public access points and facilities". The plan also recognizes the need to "increase [the] capacity of the [the] harbor and waterfront to accommodate increasing public and private use." One of the major recommendations of the Plan is to "encourage [the] use of alternative private docking facilities" to reduce demand and congestion at the town pier. The Golden Anchor Inn and Pier are listed in the Plan as one of only six facilities in the Bar Harbor area that provides "excursion docking facilities" (a fixed pier that provides passenger access to vessels berthed at floating docks), two of which are at the Marine Atlantic Terminal.

Ocean Properties considered several alternatives to the proposed dredging of the Golden Anchor Harbor and dock enhancement project. These include:

1) no action
2) install new docking space and/or moorings without associated dredging
3) adjust boat launching schedules to coincide with high tides
4) purchase a different shorefront property with adequate facilities
5) rent a nearby wharf to accommodate their increased business
6) reduce the size, scope, configuration or density of the project

They determined that dredging and expanding the current facility is the most viable and cost effective option. "Safe, navigable docking space is needed in Bar Harbor to accommodate a growing number of excursion boats. An expansion of the Golden Anchor facility is less environmentally intrusive than creating a new facility in a previously undeveloped shorefront".

The proposed dredge project includes the dredging of approximately 68,439 sq.ft. (9,235 cu.yd) from an approximately 1.57 acre subtidal area to an 8 ft. draft at low tide. The material to be dredged includes a thin layer of cobble/gravel/sand over firm sandy silty clay. The dredging will be performed using a clamshell on a lattice boom crawler crane mounted on a deck barge. The spoils will be transferred from the clamshell into a dump scowl barge, which will transport the spoils to an unconfined ocean dredge disposal site in Union River Bay. This disposal area has recently been used by the Army Corps of Engineers and the City of Ellsworth to dispose of dredged material from the Union River. The applicant estimates that the project would take 1 to 2 months and involve approximately 25 barge trips to the disposal site.

The scope and extent of the proposed dredge project have been reduced significantly since conception. The first project included dredging of approximately 3.5 acres and included both the intertidal and subtidal zones. The size and scope were reduced after concerns were raised regarding habitat losses in the intertidal zone. A third revision (reflected in the most current plans) was made following a bottom survey in which dense areas of eelgrass were closely observed in specific areas of the proposed dredge.

The proposed project acres consist of a variety of marine habitat types including irregularly exposed intertidal mudflats; eelgrass meadows; macroalgae beds, sandy bottom mixed with rocks; and rocky/cobble bottom with encrusting coraline algae. The predominant sediment type in the project area is rocky/cobble bottom with intertidal sand and silt. A wide array of fish and wildlife species use the habitat types in the project area. The rocky/cobble areas offer a variety of habitat niches for algae and assorted marine fauna including common periwinkle, whelks, various crabs, green sea urchins, sea stars, polychaete worms, sand dollars, shrimp and snails. Several fish species may feed on the abundant prey available in this habitat including winter flounder and cod. Several bird species such as American black duck, common loon, bufflehead, common goldeneye, and ring-billed gull graze among macroalgae for invertebrates.

MER Assessment Corp. of Brunswick, Maine assessed the marine bottom habitat that will be affected by the dredge. According to their reports, the flora and fauna observed in the dredge area "represent typical, common, ubiquitous species found within the region in similar habitats". Eelgrass, which is considered by the NOAA Fisheries to provide critical habitat for certain species, was observed in portions of the originally proposed dredge area in varying densities. A single adult winter flounder was also observed at the eastern limits of the originally proposed dredge area. According to the MER assessment, permanent impacts due to the dredge project are the loss of rock/cobble habitat with its complementary rockweed and kelp habitats. Temporary impacts include the suspension of particulate in the water column during the dredging operations, which can smother and shade adjacent flora and fauna. Another temporary impact is the loss of the current population of fauna.

The proposed 10' wide x 226' long float will be attached to the end of the existing float and three 10' wide x 80' long float extensions will be attached perpendicular to the eastern side of the new main float at approximately 65' intervals. Anchorage of the floats will be by chains attached to moorings. According to the MER assessment permanent impacts due to the floats include three approximately 88 sq. ft. areas below the floats that will shade and discourage plant regrowth. It is expected that vegetative regrowth will also not occur underneath the most heavily traveled lanes due to boat prop wash.

NOAA Fisheries is concerned that the Golden Anchor project will adversely affect eelgrass habitat. Although the project has been reduced to avoid dredging dense eelgrass meadows, according to the MER Assessment Corp, eelgrass was observed sporadically in five of the six dive transects. Vegetated shallows, which include eelgrass, are defined as "special aquatic sites" under Section 404(b)(1) Guidelines of the Clean Water Act due to their functional attributes as finfish and shellfish nurseries, wave buffers, sediment stabilizers, and absorbers of excess organic nutrients. The individual and cumulative impacts of this project are viewed as being more than minimal due to direct dredging of eelgrass habitat, shading from the float system and vessel activities. NOAA Fisheries has requested that the project be evaluated under the full Individual Permit review process and recommends that the permit process include a rigorous alternative analysis, which focuses on alternatives to avoid impacts on eelgrass.

EPA suggests, based on the MER survey, that while the eelgrass in the dredge area is referred to as sparse and isolated, the figures from the dive survey show that there are many of these isolated patches. This may suggest a larger eelgrass meadow with a smaller shoot density.

In addition, they are concerned that the claim that the dredge area will fill in with soft sediment and be colonized with eelgrass is not likely.

The U.S. Department of Interior Fish and Wildlife Service (USFWS) finds that the proposed dredging would both directly and indirectly affect vegetated shallows, including eelgrass meadows and macroalgae beds. USFWS feels that the diverse shelter and foraging opportunities offered by this cobble habitat would be completely removed by the proposed dredging and subsequently replaced by a uniform bottom of marine clays and silt. USFWS has similar views to EPA with regards to impacts to eelgrass habitat and recolonization. They urge the USACE to deny the permit. They suggest that the applicant should re-evaluate the alternative of installing new moorings in unvegetated areas offshore in Bar Harbor that could accommodate the variety of vessel; sizes anticipated to use the proposed float system.

Maine DMR and Department of Environmental Protection held joint public meetings in March of 2002 to hear concerns/comments from interested persons. Concerns expressed included potential adverse impacts to the soft-shell clam resource in the bar just to the west of the proposed dredge area and to the bar itself; water quality; and benthic habitat in the dredge area. In addition there was concern for potential impacts to areas affected by storm surge (e.g., potential damage to proposed floats and subsequent potential damage to surrounding property, including other boats), interference with existing recreational and commercial boat traffic, and with commercial fishing activity (particularly along the proposed barge route to the proposed disposal site).

DMR feels that despite the fact that the applicant has reduced direct impact to eelgrass by decreasing the extent of the proposed dredge area, negative impacts to the surrounding eelgrass would still result from increased boat traffic (directly from vessel prop wash and indirectly from increased water turbidity). In addition, the highly diverse benthic community typical of rock/cobble subtidal substrate would be replaced by a less complex and diverse assemblage of species characteristic of silt over clay substrate that would have the added disadvantage of being continually disturbed.

It is DMR's recommendation that, should the project be permitted, dredging and spoils disposal operations take place during the period of December 15 to April 15 in order to minimize adverse impacts to recreational and commercial boating and fishing activities.

VI.C.2. Economic Issues Considered

No economic analysis or assessment has been done related to the Golden Anchor case thus far. If the case is elevated to a higher level at USACE it is possible that some sort of economic analysis will be required.

VI.C.3. Evaluation of Economic Arguments

Although there were no explicit economic arguments made in this case, there was an implication of economic benefits that would result from the development. However, it is not clear whether the Ocean Properties project will generate substantial positive economic impacts (e.g., jobs and income) within the Bar Harbor region unless fees and lease receipts are kept within the regional economic system (and this is not obvious). In addition, it is hard to imagine that there will be any significant increase in jobs as a result of this project though there are possible local tax implications.

In terms of the assessment of the value of habitat functions and services it may be very difficult to assess the value of eelgrass habitat in this case especially given its limited distribution and lack of data supporting its function in providing services that people care about. As in any analysis of the value of habitat functions and services, making the linkage between the habitat functions and services of value to people is difficult at best.

VI.C.4. Economic Issues Not Considered

In their proposal, Ocean Properties qualitatively discusses the need for the Golden Anchor project in terms of meeting the need for excursion boat docking capacity in the Town of Bar Harbor. One might view this as an argument in terms of positive economic impacts to the Town and region as a whole resulting from an expansion of the Golden Anchor docking facility. Ocean Properties will profit from increasing docking capacity at one of their facilities. Adding additional dock space increases their ability to meet projected demand for dock space thus enhancing their competitive advantage in the moorage and dock space market. Ocean Properties argues (qualitatively) against the various proposed alternatives in terms of competitiveness and cost minimization (See exhibit 11A of their proposal).

NOAA Fisheries and the other resource agencies argue, on the other hand, in terms of the potential losses to the functions and services of habitat (especially eelgrass) from the Golden Anchor project. NOAA Fisheries has qualitatively identified the environmental costs of the dredging and expansion project and related loss in value associated with those resources to society. NOAA Fisheries feels that detailed alternatives analysis needs to take into account the functions and values of potential environmental attributes. That is, the real costs to the environment must be included in the analysis of benefits and costs of various project alternatives. For a permit to be acceptable to NOAA Fisheries compensatory mitigation for lost functions and values would be required.

VI.C.5. Improving the Decision With Economics

Important aquatic habitat management decisions, such as the permitting of the Golden Anchor dredge and dock extension project incites controversy because of difficult tradeoffs that are necessary among different stakeholder objectives. For example, the desire to preserve aquatic habitats may result in the loss of dredging and/or development opportunities (and subsequent economic impacts) for the private owner, Ocean Properties, and the Town of Bar

Harbor. On the other hand the decision to allow dredging may have significant detrimental impacts to marine resources that provide goods and services that are valued by society. Such tradeoffs are not easy for individuals to make because they typically require giving up something of value. However, from a social perspective, aquatic habitat management decisions such as illustrated in the Golden Anchor case should be addressed in light of both broad economic goals and ecosystem integrity. The question then is how best to recognize and explicitly include multiple objectives, values for environmental goods and services, and tradeoffs related to their use in the permitting decision process in a cost effective way.

There are several approaches that can aid in or is part of any decision-making process – approaches that approximate the values that society holds for environmental resources and rationalize choices about their use, management, and or preservation. In the case of the Golden Anchor dredge and dock project, these approaches can theoretically be used to identify both the commercial and environmental costs and benefits of the various options designed to minimize the impacts of dredging. This information can be used to inform the decision-makers (USACE) as to the most socially acceptable and or economically efficient options available and in general enlighten the debate. Two of the most widely recognized approaches are classical economic and risk analysis.

Environmental valuation as discussed previously is the estimation of the economic value of natural resources and services that they provide. In the Golden Anchor dredge and dock case the argument in favor of dredging and dock building is based on the potential positive economic impacts that will occur. Information on environmental values, associated with eelgrass habitat, expressed in a similar unit of measure, dollars, may be helpful in developing arguments against dredge project permitting. The biggest challenge to this approach is that there is limited data on the linkages between eelgrass habitat functions and services that are measurable using standard economic techniques.

In the Golden Anchor case, the notion of risk is tremendously important. If in fact the project is allowed to go forward, even taking into account potentially low environmental value losses, there may be long-term cumulative impacts. If no argument is made in terms of substantial valuable habitat losses, who is to say the same outcome might not occur on some adjacent property in the future and so on. Risk analysis may be one way to deal with potential cumulative impacts that are inherent with the permitting of small dredge and dock projects such as the Golden Anchor. The use of expert witness elicitation may be appropriate in this case.

An alternative approach is the structured decision approach to value assessment and public involvement (see section III.C.). The latter recognizes the need to make tradeoffs between groups, between the environment and the economy, and between alternative options. It is an approach which explicitly recognizing multiple stakeholder objectives and community values in the context of management and policy decision-making.

In the ideal world the structured decision approach would be highly effective and appropriate in permitting cases such as the Golden Anchor. However, the implementation of a structured approach remains challenging. It is challenging in part because it is different from what decision-makers or stakeholders have come to expect. It requires the development of trust between the stakeholders, decision-makers, and analysts. In addition it is potentially too time and resource consuming for small cases such as the Golden Anchor case.

VI.C.6. Generality

In general, this case demonstrates that the USACE permitting processes is lacking when it comes to identifying costs and benefits of actions, especially environmental costs. There is no requirement that an economic analysis (no real measure of tradeoffs (benefits, risk, costs) in the permitting process and parties involved appear to have no incentive to expend the resources to add economics to their argument. On the other hand, many resource departments reviewing permit applications have no economic staff and therefore the focus remains predominately physical or biological in nature. One resource agency individual stated that "it would complicate things for resource agencies to have to weigh economic implications".

VI.D. Case Study 3 – Fire Island Beach Nourishment New York

VI.D.1. Description of Action/Issue

This case study explores two separate permit applications related to dredging and beach nourishment on Fire Island, New York. One permit is for beach nourishment on the western part of Fire Island that would entail the restoration of 8,800 linear feet of beach. This would require dredging 1.3 million cubic yards of beach-compatible sand from an offshore borrow area located 1.6 miles from the restoration site. A hydraulic dredge connected to a submerged pipeline would be used to transport the sand to the beach. The sand would be graded to create a berm at 9.5 feet and a dune elevation of 15 feet. Beach width would initially be 268 feet, but would be reduced to 153 feet after several storms.

A similar dredging and beach nourishment project has been applied for further east at Fire Island Pines. This project would entail the restoration of 7,400 linear feet of beach requiring dredging of 753,000 cubic yards from a borrow area approximately one mile away. The beach width would initially be 198 feet, but reduced to 97 feet after a few storms.

The major impacts from the proposed projects, as stated in the public notices, are inverse impacts on essential fish habitat and managed species during the dredging and sand deposition part of the operation. Fish and migratory shorebirds would be expected to avoid the area during the dredging operations. Benthic communities would be disrupted but are expected to recover fairly rapidly. Potential positive environmental impacts of the projects could result from the planting of beach grass and creation of piping plover habitat.

VI.D.2. Economic Issues Considered

These projects stated purposes are to "restore the protective qualities of the beach and dune system", and to "restore the shoreline for the protection of public infrastructure and existing single family residential dwellings". Although not explicitly addressed, the underlying economic argument is that the cost of dredging and the resultant environmental damage it might create are more than offset by the benefits from the stated purposes. Thus, the focus of the arguments for project justification is the value of the beach as a protector of residences and other infrastructure.

VI.D.3. Evaluation of Economic Arguments Used

The wisdom (or lack thereof) of beach nourishment in the face of highly dynamic shoreline processes and sea-level rise has been, and continues to be widely debated. The economic benefits and costs, as well as the distribution of those benefits among the public and private sector, will vary greatly from site to site. In this case protection of both single-family residences and public infrastructure is included although there is no quantification in the public hearing notices. How many residences will be protected? Is the public infrastructure being protected truly public or only available to a limited number of individuals?

In addition to the public versus private sector benefits issue of beach replenishment is the issue of the time element. How long will the restoration last? In this case a large portion of it will be gone after several storms. The benefits and costs of the restoration activity will depend not only on the current commitment to perform the restoration, but future commitments to maintain and preserve the beach.

VI.D.4. Economic Issues Not Considered

Surprisingly, there is not mention in the project justification of the value of the beach itself for public recreation. Although Long Island beachgoers have many alternative beaches to recreate at, given the population size, high quality beaches are valuable commodities.

On the other side of the equation are the potential environmental damages due to dredging that are not discussed in the public documents. Although there is mention of fish and shorebirds avoiding the area during dredging, there is no discussion of damage that the pipeline might cause, the damage during dredging, and the alteration of habitat at the borrow area. With dynamic offshore processes, models should be developed to predict what the net effect of removing sand from the offshore borrow area will have on deposition along the coast. Basically, the sand is being mined as if it is free, but it would have a different, possibly valuable fate, if it had been left in place.

VI.D.5. Improving the Decision With Economics

An improved decision does not necessarily imply that the decision would be different had more thorough economic analysis been conducted, just that the process is more likely to result in a favorable outcome if an economic analysis is conducted. In this case, quantification of the stated benefits such as home and infrastructure protection would provide decision makers and the public a greater understanding of what is being gained from the public expenditure for beach nourishment. Additionally, quantification of beach usage and potential marginal increases in beach user value that result from the creation of the beach would be desirable.

The direct costs of the beach restoration project should be explicitly stated in the documents concerning this case. Other potential costs such as those due to environmental damage should be included in the benefit cost accounting. Finally, the opportunity cost of the sand that is being pumped ashore needs to be calculated.

VI.D.6. Generality

Beach replenishment and restoration projects are widespread, but they may not all be of special concern to NOAA Fisheries. This case appears fairly representative of the process of moving offshore sand onto specific beach locations. The benefits of such actions will vary from locale to locale depending on the structures being protected, the susceptibility to storm damage and the degree of beach utilization. For NOAA Fisheries, habitat issues will arise when the borrow area is important fish habitat or the dredging process itself harms fish. In such cases, economic analyses can be used to challenge the stated benefits of the beach replenishment and to ensure that all costs are considered, including environmental damage and opportunity cost of sand, in the analysis.

VI.E. Case Study 4 --- Salinas Valley Water Project

VI.E.1 Description of Action/Issue

The Monterey County Water Resources Agency (MCWRA) applied for a permit from the US Army Corps of Engineers to construct the Salinas Valley Water Projects (SVWP) in Monterey and San Luis Obispo counties, California. The project seeks to remedy seawater intrusion into the freshwater aquifer in the Salinas Valley (Basin). Since nearly all of the Basin's water uses (agriculture and urban) rely on extraction of groundwater, an ongoing imbalance between the rate of groundwater withdrawal and recharge has resulted in overdraft conditions that have allowed seawater from Monterey Bay to intrude into the freshwater aquifer in the Basin. Seawater intrusion has extended inland in the northern portion of the Basin and has resulted in the degradation of a large part of the groundwater in the northern Salinas Valley. In order to (1) stop seawater intrusion, (2) provide adequate water supplies to meet current and future (year 2030) needs, and (3) improve the hydrologic balance of the groundwater basin in the Salinas Valley, MCWRA is proposing the SVWP which is comprised of a series of structural and program--based components.

The Salinas River extends approximately 120 miles from the river's headwaters in San Luis Obispo County and flows north/northwest to Monterey Bay. The Project Area is defined as the Nacimiento and San Antonio Reservoirs, the Nacimiento and San Antonio Rivers downstream of the two dams, and the Salinas River from its confluence with the Nacimiento River to Monterey Bay. The SVWP involves structural modification to the Nacimiento Dam spillway (inflatable rubber dam or radial gates), modification of the water release operation at Nacimiento and San Antonio reservoirs, construction of the diversion facility (pneumatically-operated inflatable dam) at the northern Salinas River, delivery of the impounded water through Castroville Seawater Intrusion Project (CSIP) pipeline (already in place for delivering recycled water), and implementation of direct groundwater pumping restrictions.

In a nutshell, the spillway modification to the Nacimiento Dam allows the reservoir to store a higher volume of water throughout the wet season (while assuring the provision of adequate flood control capacity), which will be released more efficiently (less water in the wet season and more water during the dry seasons) at Nacimiento and San Antonio reservoirs to maximize recharge to the groundwater basin. The construction and operation of a diversion facility at the northern Salinas River allows diversion of surface water to supplement agricultural water use during the irrigation season. With this supplemental water supply in place, groundwater pumping in northern Salinas Valley will be restricted supposedly without detrimental impact to the region.

MCWRA considered several alternatives to the proposed SVWP (Alternative A) including the subsurface diversion and storage facility (Alternative B) instead of a surface facility, No action (Alternative C), Total demand management (Alternative D), and State adjudication (Alternative E). MCWRA determined that the proposed SVWP (Alternative A) is the most cost effective and least environmentally intrusive option to halt seawater intrusion and balance the groundwater basin.

There are a number of species listed as threatened or endangered under the federal Endangered Species Act (ESA) in the Project area, which includes such aquatic species as, South-Central California Coast Steelhead Trout, California Red-legged Frog, Tidewater Goby, Arroyo Toad, and such terrestrial species as the Bald Eagle, Western Snowy Plover, and Least Bell's Vireo. Under Section 7 of the ESA, the proposed action requires consultation with the NOAA Fisheries (NOAA Fisheries) and United States Fish and Wildlife Service (USFWS) to obtain an incidental take permit for activities that are likely to adversely affect the species and/or their critical habitat. MCWRA has prepared and submitted the Biological Assessment (BA) to provide the basis for NOAA Fisheries and USFWS to prepare a Biological Opinion (BO).

ENTRIX, Inc., which prepared the Biological Assessment on behalf of MCWRA, concluded that for the seven protected species identified for consideration, the Project had no adverse effects on adult steelhead, the arroyo toad, bald eagle and western snowy plover. Two species, the tidewater goby and the least Bell's vireo have not been found in the Project Area in recent times. Although the Project could result in the incidental take of juvenile steelhead and/or California red-legged frog under the limited conditions, the BA concluded the project would not jeopardize the existence or recovery of the population.

Although NOAA Fisheries sees a potential for violation of the ESA in the project, it is still in the early stage of review and the agency has not yet started its consultation process nor prepared its official biological opinions. NOAA Fisheries considers the BA prepared by ENTRIX to be lacking in details as to the specific operation to insure the conservation of steelhead. NOAA Fisheries considers the proposed Project will change the timing, frequency, and magnitude of water releases from Nacimiento and San Antonio Reservoirs to the Salinas River and thus has the potential to alter the whole water system throughout the Salinas River. From NOAA Fisheries' perspective, MCWRA's approach to the Project views Salinas River only for its utility to provide water (groundwater recharge and source of supplemental water supply) rather than considering the watershed ecosystem as a whole.

MCWRA maintains that the altered hydrologic conditions related to the proposed Project involve minor changes relative to the baseline conditions and do not alter the overall pattern of hydrology of Salinas River. The proposed diversion facility also includes provisions for a fish screen, fishway for upstream and downstream passage, sufficient bypass flow, and an alternative migration route. The timing of the operation of the diversion facility (April-October) also insures the steelhead migration. Therefore, MCWRA claims that no adverse effect on steelhead is anticipated. MCWRA will also develop a monitoring program to determine whether or not the diversion impoundment results in an incremental loss of migrating steelhead.

An Environmental Impact Report/Environmental Impact Statement (EIR/EIS) prepared by EDAW on behalf of MCWRA (in accordance with the requirement under the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA)) also estimated that 2.5 acres of riparian habitat will the lost as a result of the construction and operation of the diversion facility. U.S. Army Corps of Engineers (USACE) and California Department of Fish and Game (CDFG) regulations require "no-net-loss" of wetland with replacement habitat located near the area of impact, and "no-net-loss" to be considered in terms of habitat value on a watershed basis. The Project proposes that the loss of riparian habitat would be mitigated through replacement and/or restoration on a one to one basis through revegetation of approximately 2.5 acres of riparian habitat. Five potential restoration sites have been identified in the immediate vicinity of the impoundment study area. The exact location and planting design would be developed through consultation with CDFG and USFWS. Performance standards would be included to ensure that 80% coverage in replacement trees is achieved over a 5-year period checked by aerial photo coverage. An annual report by MCWRA to CDFG and USFWS identifying planting success and monitoring efforts would be required to be submitted by MCWRA to CDFG and USFWS.

The proposed action (SVWP) has been evaluated, modified, through different phases of the project, and has had a significant amount of public involvement. The MCWRA claims that the SVWP represents the local consensus approach to protecting the Basin's groundwater resources. Several actions have already been taken to circumvent the problem of seawater intrusion. MCWRA, in conjunction with the Monterey Regional Water Pollution Control Agency (MRWPCA) designed and constructed the Monterey County Water Recycling Projects (MCWRP), which began providing recycled water for agricultural irrigation in April 1998. The MCWRP also maintains over 500 wells to monitor the advancement of seawater intrusion throughout the Basin.

What complicates the political environment surrounding the project is an impending state adjudication process. The State Water Resources Control Board (SWRCB) initiated proceedings to adjudicate the Basin in 1996. If a local solution is not implemented, the SWRCB will adjudicate the Basin. Adjudication would result in loss of local control and oversight of the water resources and judicial control over the water resources in the Basin. The MCWRA insists that adjudication will result in massive litigation by the landowners to fight against “forced conservation”, and therefore huge legal and bureaucratic cost with no real solution.

VI.E.2. Economic Issues Considered

The proposed SVWP is substantial in its scope and complexity. Since proposed action was developed through years of planning, engineering, and public involvement, a significant amount of both qualitative and quantitative impact analysis was generated. Nevertheless, there are large uncertainties regarding its environmental effects and its effectiveness in restoring groundwater.

In the framework of benefit cost analysis, the benefits of the project may include the benefit of halting seawater intrusion, providing adequate water supplies to meet current and future needs, and improving the hydrologic balance of the ground water basin, which extends to the community at large in the Basin.

Based on the Salinas Valley Integrated Ground and Surface Water Model (SVIGSM), MCWRA concluded that a valley wide reduction in pumping of 30%-50% would be needed to halt seawater intrusion absent a project that would supply an alternative source of water. The agricultural industry in Monterey County, most of which is in the Salinas Valley, is estimated to have an annual gross revenue of over two billion dollars. Although no extensive economic analysis was done, based on the agricultural revenue generated in the region, primary annual revenue loss (not accounting for secondary effects of wages to farm labor, processing costs and revenues, shipping, etc) are estimated to exceed $32 million for Castroville and $130 million for the Pressure Subarea. The EIR/EIS states that halting seawater intrusion only through demand management (direct restriction) of groundwater use will have drastic detrimental effects on the economic health of the Salinas Valley. These impacts are expected to occur whether pumping restrictions are implemented valley wide or in more focused areas.

On the cost side of the project, it is acknowledged that the proposed project would significantly lower the reservoir levels and thus would adversely affect the local economy dependent on the use of Lake Nacimiento and Lake San Antonio. Effects on the local economy were predicted using a recreation visitation model which evaluated the quantitative relationships between historical attendance data and hydrologic /lake-level, demographic, economic, and climate data. Ripple effects on the local economy in terms of visitor spending, employment, income, and local government fiscal revenues were also estimated. For example, in San Luis Obispo County, average annual visitor spending is expected to decrease by $2.3 million, resulting in the elimination of 74 jobs and a decrease in total personal income of about $1.5 million. The annual fiscal impacts on San Luis Obispo County are estimated to be $106,600 (0.1% reduction). These effects are concluded to be significant and are portrayed as an unavoidable consequence of project implementation

The EIR/EIS also estimates the effect of the project on property values in the affected area. The project is expected to more frequently result in lake levels that are too low to support boating activities and would also adversely affect the aesthetic qualities of the immediate area.

The hedonic property--pricing methodology was used to estimate the effect of reservoir levels and housing characteristics on the value of adjacent homes. The long--term impact of the project on property values is estimated to average $7,700 per home (4.4% of the average value of improved property), while lakefront and lake view properties would likely experience substantially higher reductions in property values than the average.

Although these adverse effects of the project are identified as costs, MCWRA states in its EIR/EIS that the priority uses specified in the MCWRA's water rights license are flood control and groundwater recharge for the agricultural, domestic, municipal, industrial, and recreational uses in the Salinas Valley. The EIR/EIS concludes that although reservoirs provide recreational and aesthetic amenities, these are not the primary purposes for which the reservoirs were constructed. MCWRA further states that if the lake were operated so that water levels were not reduced, seawater intrusion would not be halted (according to their model) and the objectives of the project would not be met. Consequently, it is concluded that there is apparently little flexibility in the operation of the reservoirs that would accommodate the operational restraints.

VI.E.3. Evaluation of Economic Arguments Used

The basic framework of a benefit-cost analysis of the project is presented in the EIR/EIS. Identified cost considerations in the analysis extend beyond the simple price tag of the project itself. The benefit of the proposed project (implied by the avoidance of agricultural revenue loss) will likely be higher when the ripple effect (of the agriculture production) to the local economy is taken into consideration. Furthermore, the benefit extends to the community at large in the Basin, not just to the agriculture sector.

Since the species affected by the project area are listed as threatened or endangered under the federal ESA, no attempts were made to assess the value of habitat potentially affected by the project. This does not result from a lack of comprehensive cost analysis of the project, but rather results from a legal requirement to provide mitigation to the extent that there is no jeopardy to ESA listed species. Putting this into economic terms -- the underlying implication is that the value of these species to the society as a whole outweighs any benefit the project would otherwise generate.

Whether or not the provided mitigation measures are sufficient is a separate matter. The fact that the mitigation measures are provided in the proposed action indicates that environmental costs of the project are taken into account within the overall project design and permitting process. In addition to the mitigation measures for ESA listed species and their habitat in the project area, the project's potential adverse effect on the largemouth bass population in the Nacimiento reservoirs (via increased fluctuation of reservoir water level) is also recognized. Although the program has not been fully developed, it is stated that MCWRA will develop a habitat enhancement program at Lake Nacimiento to help mitigate this impact under consultation with the CDFG.

If, for a moment, it is assumed that the mitigation measures are provided to the extent that the project is deemed not to create jeopardy to ESA listed species, then the problem can be portrayed as classic common property problem. The groundwater resource in the Basin is hydrologically interrelated. Extraction of the groundwater by different parties collectively affects the hydrologic balance of the groundwater basin in the Salinas Valley. When overdraft resulted in the seawater intrusion into the aquifer, however, the point of intrusion and subsequent contamination occurred in the coastal area of the Salinas Valley, where agriculture represents a significant component of the local economy. If, in fact, the proposed project can only achieve its objectives by managing the water resource in a manner such that the local economy in the vicinity of Lake Nacimiento and Lake San Antonio are significantly and adversely affected, then the issue could be one of equity, who gains and who losses.

MCWRA maintains that the economic effects quantified (as economic and property value effects of the project on the local economy in the vicinity of Lake Nacimiento and Lake San Antonio) are in fact economic and social effects of the project (and not environmental effects under CEQA and NEPA). Therefore they argue that no conclusions can be made regarding the significance of these effects and no mitigation is required.

VI.E.4. Economic Issues Not Considered

The fundamental problem faced by the MWRA is that groundwater is an unpriced valuable resource, accessible to many at an economic cost far less than its economic value. There is nothing in this proposal (that I've seen) that addresses this problem. The diversion will only provide a short-run solution if there is no total demand management jointly implemented. For efficiency, charges on the use of groundwater would be equal across different user groups and would be sufficient to preclude wasteful uses of groundwater.

As stated above, the basic framework of benefit-cost analysis of the project exists in the EIR/EIS, and identified cost considerations go beyond the simple price tag of the project itself. Environmental costs of the project are recognized and taken into account for overall project design and for the permitting process. Economic and social effects of the project "on the human environment" (such as the recreational economy reliant on the use of lakes, aesthetical value of the lake on property value, and so forth) are also recognized and their economic effects are quantified, though no mitigation was pursued for that effect.

The question then is whether or not mitigation measures included in the proposed action is sufficient, not only in terms of their effectiveness but also for the true economic value they reflect. In other words, the question is whether the environmental costs of the project are taken into account to their full extent. For example, is the loss of 2.5 acres of riparian habitat adequately compensated for to society through revegetation of habitat on a 1 to 1 basis with the performance standards of 80% coverage achieved over a 5-year period? Is the risk factor and/or cumulative effects of the project adequately counted for? Aside from the effectiveness of the measure itself, this question (whether the measures reflect the full value society places on the environment) needs to be addressed for all the mitigation measures included in the proposed action.

There is also a cost on the other side of the equation. Seawater intrusion is taking place at a very slow rate over a long period of time. Nonetheless, continuous degradation of groundwater resources is currently taking place. In other words, inaction or unduly postponing the action has its own cost to society.

VI.E.5. Improving the Decision with Economics

One may think that economics may not have a role in a project that involves ESA listed species and its habitat. It is a legal issue to provide mitigation to the extent that the project finds no jeopardy to ESA listed species. However, it is also important to put the underlying implications into the same economic language so that they constitute society's conscious decision; that the value of these species to society as a whole outweighs any benefit the Project would otherwise generate.

Economics provides tools to measure value, thus it can provide the framework to rationally look at the project. What are the benefits of undertaking the project, and what are the costs? Are there any equity implications involved regarding distribution of the cost and/or benefit? Are the full costs to the environment and resources taken into account? Are any mitigation measures taken to minimize the impact, thus tilting the scale of benefits and costs? Is the cost of providing mitigation taken into account? Aside from the effectiveness of the mitigation measures themselves, do the measures reflect society's full value of the environment or resources? Is the notion of risk taken into account? What about the project's potential cumulative impacts? Another important economic factor which is often ignored is a cost effectiveness of project implementation which includes the cost effectiveness of the permitting decision process.

A tremendous amount of resources have been expended to generate the EIR/EIS, and to reach this stage of project proposal. Numerous workshops and public hearing were held to hear concerns from different stakeholders affected by the project. As responses to the public comments on the draft EIR/EIS, additional economic impact analyses, additional mitigation measures, a resurvey of riparian habitat, and so forth were undertaken and the results were included in the final EIR/EIS. The final EIR/EIS includes 174 letters with responses to individual points and questions addressed in each letter.

If the issue of cost effectiveness of project implementation is to be raised, it may require review of the effectiveness of the permitting process. Coordination efforts among different overseeing resource agencies may be necessary. Language in the requirements may need to be more clearly defined. Consultation and involvement of the overseeing resource agencies in the early stages of project development and design may also be called for. Overseeing agencies' involvement in the public hearing and workshop process may be beneficial. To take all elements into balance, the cost of inaction or foregoing an opportunity to provide nonmarket goods of value to society (through development of the Project) should be recognized as such.

VI.E.6. Generality

The proposed SVWP is substantial in its scope and complexity but constrained in its long-run vision. The problem presented here portrays a very realistic picture of complex legal, economic, social, and political elements involved in undertaking a project which could potentially provide a nonmarket good. This good, however, has a significant cost associated with it. Economics may be viewed by the permit applicants as yet another expensive hurdle to clear, another time-consuming bureaucratic burden placed upon them. Economics may also be viewed by the resource agencies as something that complicates their jobs. However, economics can provide a common denominator for comparison of various benefits and cost generated by the proposed project so that we can compare them, weigh their importance, and ultimately achieve balance. When data are lacking, some proxies may be needed to estimate the full value of the affected element. This can only be done if the framework is in place. The cost effectiveness of project implementation, including the permitting decision process, should also be factored into the equation. Some consideration should be given to demand management through a pricing (or taxing) program. At present it is not clear why this solution will provide relief in the future when greater and greater demands are placed on groundwater.

VI.F. Development of Quonset/Davisville Port and Commercial Park In Narragansett Bay

VI.F.1. Description of Project

This proposed project by the Rhode Island Economic Development Corp. (RIEDC) involves channel dredging and port development in and around the site of an abandoned naval base at Quonset Point, Rhode Island. The project will result in a modern highly automated seaport that will be designed to handle primarily container vessels carrying cargo bound for destinations outside of Rhode Island. This new port will need to compete successfully with other east coast container ports offering similar services, including Montreal, Halifax, Boston, NewYork/New Jersey, Philadelphia, Baltimore, and Norfolk. As proposed, the project would require dredging new approach channels to a controlling depth of 52 feet and filling up to 115 acres of open water to create the port. The project is still at the "prefeasibility" stage, but it is the focus of an Environmental Impact Statement (EIS) planned to begin in 2002, and is being aggressively advocated and opposed by various interest groups in the state.

The initial master plan for the project was released to the public in 1997 and faced strong opposition from environmental organizations, resource agencies, and citizen groups. As a result, the Rhode Island governor at the time, a strong advocate of the project, formed a "stakeholder group" to consider a broad range of port development alternatives for the site. The concerns expressed by this group resulted in a slightly modified master plan for the port and the establishment of ten very general goals to guide waterfront development at the site. These included commitments that the project would be economically feasible, environmentally sensitive, respectful of other businesses, assessed using an open and thorough process, etc. The state's recent (2001) application to the USACE for dredging authorization is based on the master plan released in 1997, with a few minor modifications.

Before the state submitted its application in 2001, the Army COE hired a port development expert to review the economic and market assumptions and projections contained in a consulting report which the state was relying on to justify its proposed master plan. The Corps concluded, on the basis of that review, that the assumptions used were "basically solid," but identified some areas that needed "further study during the permitting process." A subsequent "reconnaissance" investigation by the Corps concluded that sufficient justification existed to proceed with the "feasibility phase" of an investigation into the possibility of establishing a federal channel at Quonset/Davisville. However, having the USCOE begin to consider the economic feasibility of a federal channel at the site created an opportunity for project proponents. On the one hand, if the project passed a benefit/cost analysis performed by the USACE in cooperation with the state, it would qualify for federal funding and probably gain widespread support. On the other hand, that benefit/cost analysis would need to be performed using the relatively strict principles and guidelines established by the USACE. If the project failed the USCOE benefit/cost test, it would provide powerful ammunition to opponents of the port and would seriously jeopardize prospects for gaining state funds for further port studies.

In the fall of 2001, the state of Rhode Island decided to pursue a "state-only" development option and requested that the Corps defer any further investigation of whether a federal channel at the site was justified on economic or environmental grounds. Taking this position does not eliminate the role of the USACE in evaluating dredging and development permitting, but it does mean that no federal participation would be required in ongoing economic feasibility studies and that there would be no federal cost sharing. The Corps is still responsible for performing an Environmental Impact Statement for the proposed port development, but this does not involve any benefit/cost comparisons.

In January 2002 the state submitted its regulatory applications for channel dredging and port development to the Corps for permitting. The Corps, along with other federal agencies and contractors, are now in the process of developing an Environmental Impact Statement (EIS) for the proposed project. This EIS will focus exclusively on environmental effects, not financial feasibility or economic impacts. However, findings from the EIS eventually will form the basis of some important economic assessments of costs and risks related to expected impacts on fisheries and marine habitats.

During June 2002, the Corps held two "scoping meetings" in the vicinity of the proposed port where the public was presented with the master plan included in the permit applications and were asked to respond. The results of these meetings are now being used to establish the scope of work for the EIS for the project which will determine what environmental studies are needed. The EIS scope of work is expected to be released by the end of September 2002, and the EIS itself is due for release in draft during July 2004, with the final EIS expected in July 2005.

VI.F.1.a. Issues of Interest

Quonset Point is located in a part of the Narragansett Bay where commercial and recreational fisheries exist for northern lobster, northern quahog and winter flounder. The project is expected to adversely impact these fisheries and, although an exact footprint has not been established, could eventually affect more than 1,000 acres of aquatic habitat. Increased shipping also presents risks in terms of invasive species (e.g., ballast water exchange) and the release of toxic substances into the water column (e.g., propeller dredging of contaminated sediments). Dredging activity and the placement of dredged material are another source of potentially adverse environmental impacts.

Until studies are undertaken as part of the EIS, the extent of these adverse environmental impacts and their economic repercussions are not known. Until the economic and market studies associated with the proposed project are complete, the commercial viability and economic impacts of the project are not known. However, proponents and opponents of the project have developed economic arguments and organized some basic economic data to support their positions.

Interviews indicate that proponents of the project are concerned that delaying the development of the port will result in missed opportunities for Rhode Island by allowing competing ports, especially New York/New Jersey, to further develop their competitive advantages, thereby reducing the economic viability of developing a port at Quonset Point. On the other hand, opponents of the project, especially those who oppose it primarily on economic rather than environmental grounds, fear that merely initiating an EIS that will take years to complete and probably result in years of further debate will inhibit the development of the Quonset Point site by business interests that can take advantage of existing transportation system (roads, rail and ship) and can make use of the existing waterfront without the need for costly filling and dredging. Both of these economic arguments are valid, and both sides have anecdotal evidence that their positions are valid. As of August 2002, most of the candidates for governor as well as representatives of thirteen cities and towns have asked Governor Almond to stop state spending on the EIS. On the other hand, the governor and other political and industry leaders in the state are still firmly in support of the project. Some proponents are in favor investing significantly now in port-related infrastructure (e.g., road and rail connections) to keep the option viable, to illustrate to shippers who may be negotiating long-term commitments to other ports that Rhode Island is serious, and, perhaps, to increase "sunk" costs that will be lost if the port project is abandoned.

VI.F.2. Economic Issues Considered

The outcome of most types of economic assessments depends on the accounting stance that is taken (e.g., local, regional, state, national). At the broadest scale, for example, the important economic issue is whether the U.S. really needs another east coast deep-water container port. Even though international shipping in and out of east coast ports continues to increase, increases in business at one port almost always comes at the expense of decreasing business at competing ports. Existing east coast ports seem to have accommodated the significant recent growth in containerized cargo and the increasing size and draft of vessels, and have well-publicized expansion plans underway to meet future shipping needs. From a national economic perspective, therefore, the burden of proof is on the state of Rhode Island to establish that the proposed port can be successful in attracting shipping business away from competing ports, and can do so without imposing significant economic costs on its residents and the nation.

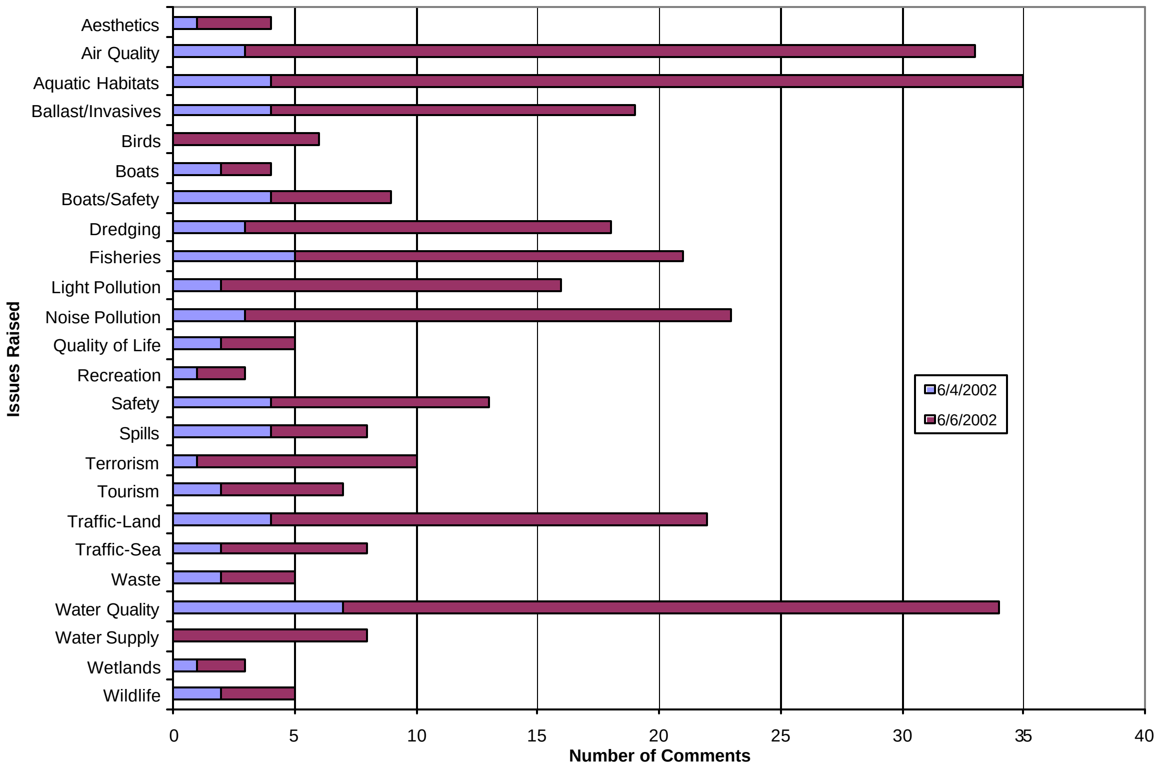
Since the state of Rhode Island intends to operate the port as a "landlord" where land is leased to private port developers and operators, it will also need to demonstrate that it can attract private investors who are willing and able to develop the port, and meet their lease commitments, and can compete successfully with other ports. It is not clear from the available project support documents that this is the case. From the perspective of the state and federal agencies, of course, the concern is that the public sector, by default, will bear the cost if commercial port interests cannot or will not invest or price their services to be competitive. Because the lag times involved are so long, it is not uncommon for commercial interests to make tentative rather than firm commitments at the early stages of port development, leaving them the opportunity to negotiate better deals once the public investments (and sunk costs) in the port are in place. Of course, shippers and ocean carriers are frequently negotiating with many ports and have more information about inter-port competition than any single port. This "asymmetric information" puts public port administrations at a distinct disadvantage when negotiating with shippers and ocean carriers.

On the other hand, one can see from a purely Rhode Island perspective that investing as soon as possible in a new port, although inherently risky, provides an excellent chance of attracting port-related jobs, incomes, and businesses away from other ports before they overcome some of their limitations. According to project proponents, all existing east coast ports are becoming limited in their ability to compete. New York/New Jersey has channel depth limits and land and water traffic congestion problems; Montreal requires lengthy transit on the St. Lawrence River and draft and winter weather restrictions that are costly to shippers; Halifax has limited and expensive ground and rail connections; Norfolk has "lost its competitive edge for intermodal cargos and is without a large nearby population base to expand,". From the state's perspective initiating an EIS may not seem like an expensive way to keep open the opportunity for the state to take action in the future if, for any reason, the proposed new port appears to be more favorable to port developers and shippers than other ports.

Although in-depth economic and market studies have not been undertaken, many interested parties, including some shipping and port experts and federal agencies, express strong reservations about whether the enormous cost of the project to taxpayers (roughly $450 million in initial costs plus $90 million in roads and rails, and perhaps another $400-$500 million in port construction costs can be justified in terms of tax revenues, business development, or job creation. Although the details cannot be known now, and may not be known until the proposed port is open for business, other east coast container ports, which are already investing to expand their operations, will compete aggressively to prevent losing business to a new port at Quonset Point. The benefits from the proposed project, therefore, are at risk not only because it may not be able to compete under current economic conditions, but because some competitive forces will not even be apparent until at or near the time the Quonset site is open for business. By this time the site may be irreversibly committed to being a container port, precluding most competing development interests (e.g., technology parks, marinas) from using the site.

While conventional economic costs and benefits are receiving the most attention from proponents and opponents of the project, the potential environmental and "quality of life" issues are the main concerns of many others. Figure 2 summarizes the concerns expressed by stakeholders at two public hearings on the proposed project conducted by the USACE in June 2002. Although these comments refer to environmental issues being addressed as part of the EIS, which explicitly does not deal with economic issues, many of the environmental issues

Figure 2
Summary of Issues Raised at Scoping Sessions
Quonset-Davisville Port Development Proposal
Session 1: June 4, 2002 (Providence, RI) Session 2: June 6, 2002 (New Kingstown, RI)



raised do have economic consequences and, in some cases, are probably being raised because of them.

In recent years, environmental economists have worked extensively attempting to quantify the economic costs associated with most of the environmental issues listed in Table 2 in order to incorporate them more directly into decision-making and into formal benefit-cost analysis. The economic issues that will be the focus of most discussion over the next few years regarding the proposed port will involve its economic viability, its fiscal impacts on the state, and its potential economic impacts on the state and the region. However, the potential economic costs associated with the environmental concerns listed in Table 2 could, in the final analysis, determine whether political support for the project grows or shrinks. It is important to determine how important some of these issues are to people, how they feel it will affect their lives, how much it will cost them or affect their "quality of life," and so on..

VI.F.3. Evaluation of Economic Arguments Used

VI.F.3.a. Project Proponents

Proponents of the project claim that the regional demand for container port facilities is growing, that the supply of these facilities at existing east coast ports is inadequate, and that a container port situated at this point on the North Atlantic coast has the potential to serve three broad inland markets, including: the New England region, the greater New York/New Jersey area, and the Midwest area, including commercial centers in greater Chicago and western Pennsylvania.

According to project support documents, “a key to attaining success for a container terminal at this location is its ability to serve inland markets effectively through the use of intermodal rail and truck services for containerized cargoes.” The economic analysis of the proposed port development “assumed that the needed truck routes and projected traffic would be available.” Based on that assumption and the presumption, based on best professional judgment, that the port could attract business from competing ports, the consultant report prepared to support the state’s application to the USACE concluded that the port should be able to achieve throughput levels of 400,000 TEU (trailer equivalent units) in the first year of operation, followed by growth to 1.9 million TEU in year 20. About 50 % of this container traffic is expected to transit the port via truck and about 50% via rail

Using the most modern automated container handling equipment, the proposed port was estimated to be able to handle this level of traffic at competitive costs and with a relatively small “environmental footprint.” Since the development site has already been designated a “brownfield,” the land-based environmental effects of developing the site are considered by project proponents to be minimal. The proponents acknowledge that further studies will be needed to establish the environmental effects of dredging and the effects of port development on terrestrial ecosystems and land use.

Preliminary economic impact analysis performed in 2000 as part of the Quonset Point Feasibility Study estimated that the construction of the port would “generate” over 1,000 direct jobs “and peak at 3,000,” and that the port would generate 600 full-time direct jobs and 1,800 jobs “created by new and expanding businesses” in the first year of operation, and over 3,200 direct jobs and induced jobs of 3,200 in year 20 when the port would be operating at full capacity. Annual wages for direct and induced jobs would be approximately $82 million initially, and grow to about $400 million in year 20.

VI.F.3.b. Project Opponents

Project opponents, led by several environmental groups and members of various stakeholder groups, have initiated a point-by-point challenge to the assumptions and analyses used by project proponents. They claim that project proponents are ignoring serious economic obstacles facing port development and some important adverse economic impacts of the port simply because they have not yet been studied. In some cases they are providing their own preliminary analysis. They have developed “fact sheets” and prepared editorials for newspapers where they describe invasive species problems caused by shipping at other ports, and point out that ships are unregulated high-volume mobile sources of air pollution. They further point out that impacts of ship traffic on the state's important recreational boating and tourism industries have not been addressed and that the effects of port development on the luxury housing in the vicinity of the proposed port have not been addressed. They point out that 115 businesses employing 6,000 people already exist in the area, and that their continued growth is being affected by the fact that port development is even being considered. Opponents also challenge the proposed port's ability to attract shipping away from New York/New Jersey, and dispute the numbers presented by project proponents indicating, surprisingly, that it will be less expensive for New York-based importers to deliver to the proposed Rhode Island port and have cargo shipped overland to New York than to ship directly into New York.

However, the most significant criticisms opponents of the project have about the economic analysis performed to date involve the critical land-links between the port and inland markets. They point out that essential rail and road links do not exist and projects to construct them, although they have been designed, are not fully funded. Opponents further assert that the full taxpayer costs of the proposed development, including port infrastructure, dredging, and construction of essential rail and highway connectors will be approximately twice the proposed $450 million being reported. They claim that the ongoing economic analysis of the proposed port focuses almost exclusively on the port itself, and not the indirect and induced effects of the port on the economy and "quality of life" in the state. They say their preliminary assessment of the economic facts leads them to believe that development of the port will have an adverse economic impact, whether it succeeds or fails to generate business. They are waiting to review further economic analysis that the state will need to develop over the next few years as part of its formal project proposal.

The arguments that opponents of the project make to characterize the potentially adverse environmental effects of the project are, at this time, more fully developed than those presented in project support documents. This will certainly change as studies to support the EIS are completed over the next few years. For now, however, the environmental issues that are of particular concern to project opponents include:

- the approach channel to the proposed port is one of the most heavily fished and productive lobster fisheries in the bay
- dredging and propeller wash would re-suspend pollutants and allow them to drift into areas with sensitive benthic communities
- dredging to the proposed depth of 52 feet would create a physical barrier to migrations by some marine organisms, and could cause poor flushing, resulting in extremely low dissolved oxygen with associated biological and habitat impacts
- efforts to re-establish eel grass beds would be adversely impacted, discouraging further investments in eelgrass recovery.
- ship traffic would affect various marine mammals that frequent the bay and the sound, including Longfin, Pilot, Minke, Right, Humpack, and Finback whales, some of which are endangered, and would affect leatherback turtles, loggerhead sea turtles and the endangered Ridley turtles

There is no doubt that these environmental impacts will be addressed thoroughly in the EIS. For purposes of this case study, however, the important matter is whether they will also be addressed as part of the economic analysis of the proposed project. The principles and guidelines used by the USACE to perform benefit/cost analysis of these projects require that they consider the economic benefits and costs associated with "non-marketed" environmental goods, services, and amenities. It remains to be seen if the economic analysis prepared by the state of Rhode Island deals adequately with these issues.

VI.F.4. Economics Issues Not Considered

There are many questions left unanswered at this time. What are the indicators of excess demand? Have imports been rising or landings fees been increased? Those seem critical evidence that is not shown. Also, what direct revenues will the state obtain from the shipping? Will these be sufficient to offset the costs of port development including infrastructure?

The economic research supporting the proposed project is very sketchy at this time and, presumably, will be expanded as the state develops a formal proposal. Existing project support documents focus primarily on port economics with very little regard for the ancillary investments in road, rail, dredging, and so on that will be needed to make the project viable. There is virtually no consideration of indirect project costs associated with environmental impacts or space-use conflicts at sea, and very little serious analysis of potential road/rail congestion on land.

More importantly, the project support documents justify the market demand for the port and forecast expected throughputs of cargo and containers based on best professional judgment, and do not refer to any formal demand or market analysis. Project documents do not indicate how managers of the proposed port expect to be able to attract shippers away from competing ports except to point out that the proposed port will be more efficient and have lower costs. They do not explain whether the comparative advantage they believe the proposed port has will persist in the likely case that competing ports lower their fees and make investments to prevent shippers from moving out. The proposal does not indicate how the decision to make the project a "state-only" venture, with no federal cost share, will affect start up costs and how the port managers will overcome the disadvantage of choosing this strategy when competing with existing ports that are already operating effectively and receive federal cost-share money.

The economic analysis presented in project support documents presents specific estimates of the jobs and incomes associated with the development and operation of the port, and characterize them as benefits. There are two problems with this analysis. First, payments to labor are more correctly characterized as project costs, not project benefits. The benefits of the project, of course, will be generated if and only if the cost savings to shippers and ocean carriers from using the port are sufficient to attract them away from other ports and, at the same time, allow them to pay fees at the new port that are adequate to compensate the state and its port tenants for paying all these workers (and also spending on equipment, capital, land, etc.). If this is not the case, the payments to workers at the port will involve direct transfer payments of tax dollars and, under most assumptions about how taxes are generated, will result in no net increase in jobs or incomes.

The second problem is that the employment and income figures that are used are based on experiences at other ports where port operations are relatively *labor-intensive.* The comparative advantage of the proposed port as purported by project proponents is that it will be highly automated, that is, *capital-intensive*, and will therefore be more efficient than existing *labor intensive* ports. This suggests that the new port cannot have the same employment impacts as existing ports.

One indicator of how important this issue may be is the fact that at the time this report was written, west coast longshoremen were forced by Presidential Order to return to work following a coast-wide strike where the primary issue involves the protection of jobs at ports that are planning to modernize and become more automated. Since containers are expected to arrive at the proposed port and leave by truck and rail without being opened, most of the jobs related to port operations will involve container handling, not the "value added" processing of cargo. This significantly limits the indirect and induced jobs generated by the port. The burden of proof will be on port advocates to show how investing in an automated system to achieve a high-volume throughput of containers will add significantly to local employment opportunities.

There are also other problems with using job creation as a measure of the benefits of this project. Unless unemployment in the region is high enough for these new jobs to be filled without drawing workers away from other local jobs, these new jobs will go to workers moving into the region from elsewhere. This creates positive regional economic impacts in some ways. However, it also puts additional pressure on local infrastructure, utilities, schools, real estate markets, etc. When a large number of temporary jobs are created to construct the port significant economic disruptions can occur as visiting workers come to the region with their families and then leave. The alternative, of course, is that they come to the region without their families and send much of their pay back home. Either way, unless unemployment in a region is high enough for the new jobs to be filled by local workers, the job-related benefits need much more careful analysis.

Finally, it is important to note that the financial and economic analyses prepared to support this project, to date, have not addressed the fact that investing in ports, especially new ports, is inherently risky. Risk analysis in the form of sensitivity tests showing how the outcome and impacts of the project would change if certain assumptions or forecasts turn out to be wrong should be at the core of any financial/economic assessment of this project. With this in mind, the economic research supporting the proposed port, at this time, suffers from two general problems. First, it is based primarily on a vision of how the project could succeed, rather than an assessment of whether or not it is likely to succeed. Second, it is based on a narrowly defined concept of costs and benefits that ignore the many ancillary investments that will be required to make the port work, and the many indirect costs associated with environmental impacts, space use conflicts, "quality of life" issues, and adverse effects on tourism, boating, fishing, and competing uses of the bay. The "opportunity cost" of committing the site to port development in ways that limit the potential for other forms of development (e.g. a yachting center or industrial park) have also not been considered.

VI.F.5 Improving the Decision With Economics

VI.F.5.a. Short-Term Improvements

As the economic justification for this project proceeds, NOAA Fisheries should make sure that the underlying analysis is logical and consistent. In this case study, for example, proponents should not be able to rely on statistics from old (labor-intensive) ports to assess employment impacts and then assert that its ability to attract business from those ports will be based on modern automated (capital-intensive) cargo handling facilities. NOAA Fisheries should also work to have the fishery and marine resource-related environmental impacts characterized in terms of their potential economic costs. These should not be associated merely with their incremental impacts (e.g., $60,000 in lost fishery revenues caused by sedimentation during dredging), but on cumulative and overall risks associated with reaching critical ecosystem thresholds (e.g., fishery or ecosystem collapse). The unfortunate fact is that when fisheries have been poorly managed the marginal economic value due to an environmental change is extremely low, resulting in extremely low estimates of fishery-related benefits from modifying dredging or port development. Attempts should be made to characterize fishery impacts under conditions where fisheries are better managed (e.g., maximum economic yield) as well as under existing conditions. The low marginal value of poorly managed fisheries should not result in a situation where habitat conservation advocates have no economic basis for supporting the protection of the only resources on which a recovery of fish resources and fisheries must depend.

As the EIS for this project proceeds, NOAA Fisheries should make sure that impacts on fisheries and marine-related ecosystems are characterized in terms of incremental and cumulative risks, and of the potential for adverse conditions reaching threshold stages where they are irreversible. This should include a time-series analysis of relevant variables showing conditions and unavoidable threats, and an analysis of the costs and risks associated with ecosystem restoration projects that are underway elsewhere where threshold levels of impacts were exceeded.

Rhode Island resource economists, used in the next case study, have been called upon to do research on environmental effects of dredging. Why haven't they been used here? The data are available and a model developed already.

VI.F.5.b Long-Term Improvements

In all coastal regions where dredging and port development pose continuous and unavoidable threats to fisheries and marine ecosystems, NOAA Fisheries should develop the capacity to critically evaluate all assumptions, assertions, and forecasts used to justify these projects. It should also have the technical capacity to evaluate, and where possible, help justify alternative development projects that involve fewer adverse marine resource impacts.

For each of these regions NOAA Fisheries should help develop a portfolio (or shopping list) of potential environmental beneficial use projects (e.g., island, reef construction, wetland restoration) and understand enough about the economics of dredging (e.g., transporting and handling costs) and the costs and risks associated with ecosystem restoration (e.g., site preparation, planting, monitoring) to know when each potential project might be justified. A similar portfolio of potential mitigation projects should be developed for each region. Many environmentally beneficial use projects and mitigation projects tend to be rejected out-of-hand either because they are determined by port engineers to be "too costly" or based on "unproven technologies" that are "too risky." NOAA Fisheries should develop economic capacity that integrates areas of ecosystem valuation and ecosystem restoration to establish the rules for how and when such determinations are made. Since the technical and economic issues here are very similar across the country, this database should be centralized, either virtually or physically. The in-house capability should be oriented toward providing rapid response, low-cost support for regional NOAA Fisheries staff who are familiar with specific regional political, economic, and environmental issues.

VI.F.6 Generality

This is clearly a case of huge upfront costs with uncertain returns. Issues on how we treat the uncertainty and discount the returns are applicable to other scenarios of similar magnitude but involving different issues. This is also a case of a few obtaining large gains where many other pay the costs. These distributional and equity issues are applicable to other circumstances.

Investing in harbor facilities and dredging is a necessary, but not sufficient condition for a port to attract shipping and related regional economic benefits away from competing ports. Because of the long lags before benefits can be expected and the potentially adverse effects of shifts in international trade and shipping, labor relations, environmental restrictions, and, most importantly, the strategies of competing ports, such investments sometimes verge on being purely speculative. On the other hand, making such investments in the face of widespread uncertainty is the only way for an existing port to hold its competitive edge, and for a new port to have any hope of gaining one. The analyses that port engineers and economists use to defend the benefits of port and dredging projects, in other words, are usually no more reliable than the analyses that fishery scientists and natural resource economists might use to provide evidence that the environmental costs are too high or require mitigation.

Without strong evidence to the contrary, political and industrial leaders hoping to lure the regional benefits that shipping can bring are prone to make the most generous assumptions about the "competitive advantage" of their port, and about the benefits and economic impacts the proposed project will generate. Without strong evidence to the contrary, they are also prone to ignore the ancillary public investment that will be required in "complementary" shore-side investments, and even irreversible economic and environmental impacts a port development project may cause. NOAA Fisheries and other resource agencies and the environmental organizations that align themselves with fisheries and marine resources interests need to be prepared to challenge economic analyses on a point-by-point basis using analytical tools and data that are at least as credible as those being used by project proponents.

Conventional benefit-cost analysis will rarely justify incremental investments in port development and/or dredging in situations where the other necessary conditions for a successful port do not exist. Nonetheless, such investments are nearly always made and, in time, may become the "sunk costs" that are used to justify additional investments. The strategy of project advocates is often to increase sunk costs in a development project until there is no reasonable way to oppose the project on economic grounds. The only reasonable response to claims of potential environmental impacts is to propose mitigation. NOAA Fisheries should develop the skills to oppose clearly speculative projects that have adverse environmental consequences as early as possible on economic as well as environmental grounds. The only later options might be to advocate a reasonable level of spending on environmental mitigation.

VI.G. Providence River Federal Navigation Project

VI.G.1. Description of Action/Issue

The Providence River Federal Navigation Project ("the project") involves dredging the approach channel to the Port of Providence, Rhode Island. The channel begins near the head of Providence Harbor and follows the Providence River south for 16.8 miles until it reaches deep water in the Narragansett Bay. Although the channel has a federally authorized depth of 40 ft., it has not been dredged since 1971, and shoaling has reduced the controlling depth of the channel to as shallow as 30 ft. This shallower depth creates significant navigation safety and environmental hazards, and increases costs to shippers and ocean carriers delivering cargo to the Port of Providence.

To minimize the risk that shoaling in the channel will cause collisions and groundings the USCG currently restricts channel use to one-way traffic and to vessels with drafts no greater than 35 ft. Vessels with deeper drafts must "wait on tide" (wait for high water) before entering the channel, or must be "lightered" (have some of the cargo transferred to smaller vessels) or "light-loaded" (have cargos removed to reduce draft). These requirements increase the cost of delivering cargo to the Port of Providence. As the average size of ocean-going cargo vessels increases, these costs also increase.

During 1997, over 86% of the cargo delivered to the port consisted of petroleum products, mostly gasoline and heating fuel used by Rhode Island businesses and residents. Most of Rhode Island's fuel storage capacity is based at or near the port, and in 1997 fuel deliveries to the port supplied nearly 98% of the state's fuel needs. Some project documents report that the high costs of delivering fuel into the Port of Providence are already being passed along to regional consumers in the form of higher energy prices.

Besides increasing dollar costs to shippers, and possibly to consumers, and creating safety hazards, channel shoaling also increases the likelihood of oil spills and other environmental threats associated with vessel groundings and collisions. It is also reported to result in contaminated bottom sediments being "propeller dredged" (re-suspended into the water column by deep draft vessels) where they adversely affect living marine resources. Proponents of the project argue that eliminating these hazards will generate marine resource benefits that offset at least some of the adverse marine resource impacts associated with dredging and dredge material placement.

Over the past ten years several dredging options have been considered including different channel depths (37' – 40') and widths (500' – 600'), alternative dredging methods (mechanical, hydraulic, and hopper dredging), and also dredging "windows" (periods when dredging is not allowed). Initially, over 150 potential dredge material disposal options were screened, but by 2001, the list was eventually narrowed to 16. The 16 sites include a mix of upland, open water, and confined aquatic placement sites, and beneficial uses of dredged materials for the creation/expansion of parks, wetland restoration, offshore reef creation, island creation/expansion, and upland disposal.

Based strictly on potential impacts to fish and aquatic habitats, the preferred option would include dredging windows that preclude dredging when and where it is expected to adversely affect fish, and upland placement rather than open-water placement of dredged materials to minimize impacts on benthic communities and aquatic habitats. If low-cost innovative technologies could be developed to use dredged materials to construct wetlands, islands, and reefs, they too might be preferred. Unfortunately, all of these options were determined to be too costly or risky, and most had such limited capacity to handle dredged material that the cost of developing and testing the necessary technologies was not considered worthwhile. Those concerned about fisheries and marine habitats were forced to consider "second-best" options that included open-water placement of dredged materials and involved at least some potential adverse marine resource impacts.

Based on scoping sessions held over the past few years, the public and various interest groups were found to be interested in having state and federal agencies address the following issues before developing a dredging plan for the Providence River:

- Alternatives to dredging
- Alternative disposal sites
- Cost of dredging
- Effects on fish and the fishing industry
- Sediment quality and related dredging and dredge placement effects
- Water quality effects
- Effect on the marine environment
- Navigation safety and accident potential
- Economic impacts of shoaling

A great deal of research by the USACE and other federal and state agencies and consultants analyzed these concerns and produced thousands of pages of project-related documents. Finally, in August 2001, the USACE released the final EIS presenting its findings and a Preferred Alternative list:

> "The preferred alternative restores the channel to its authorized 40-ft. depth and to a width of 600 ft. This is expected to eliminate the safety and environmental hazards caused by shoaling and allow two-way traffic for all but the largest classes of vessels that visit the Port of Providence. Dredging the channel itself will require the removal and placement of 4.3 million cubic yards (cy) of sediment (enough to cover 160 acres of land to a depth of 20 ft.). Non-federal dredging of .5 million cy to support the operations of the 27 marine terminals in the port, and to meet dredging requests by marinas and other facilities throughout the Narragansett Bay, increase the total amount of dredged material associated with the project to about 4.8 million cy. Because the port has a long history of industrial use, approximately 25% of the dredged material, or 1.2 million cy, is contaminated and will need to be put in confined placement sites and capped with clean dredged material. The rest is suitable for open-water placement. Using a standard clamshell bucket dredge, the project is expected to require 582 days of

dredging which, if undertaken continuously, would take place over approximately 20 months. “

The specifics of the preferred dredging alternative include:

1. Dredging continuously, but sequencing dredging to minimize impacts to aquatic resources.
2. Placing approximately 1.2 million yd^3 of contaminated dredged material in confined aquatic disposal (CAD) cells within the channel.
3. Disposing of approximately 5 million yd^3 of suitable material at an offshore site (Site 69b).
4. Dewatering and storing sand and gravel excavated from CAD cells at upland sites for later beneficial use by public and private organizations.
5. Using a small portion of excavated sand and gravel to restore colony nesting waterbird habitat at Spar Island in Mount Hope Bay.

VI.G.2 Economic Issues Considered

The benefits of the project are associated primarily with reduced shipping costs resulting from two-way channel traffic, fewer tide-related delays, and less “lightering” and “light loading.” Other benefits are associated with preventing the Port of Providence from becoming noncompetitive, a situation that would result in goods being shipped into other ports and transported to the region by rail or truck. Besides making imported products more costly in the region, this overland delivery of cargo to the region would also impose higher costs in terms of road congestion, increased highway maintenance, air pollution, etc. Most advocates for the project point out that without the project the existing investments in fuel storage capacity at the port might be “stranded,” resulting in significant net economic losses to the region. The reduced risks of oil spills from vessel groundings and collisions and the reduced incidence of propeller dredging are identified as additional sources of benefits. Ancillary dredging taking place as part of the project is expected to result in additional benefits by eliminating shoaling at marinas and boatyards and improving the access of pleasure boats and fishing boats to these facilities.

Besides the dollar costs of developing and carrying out the dredging plan, the project is expected to have environmental costs associated with temporary increases in suspended solids and contaminants, burial of aquatic resources, and adverse effects, at least temporarily, on commercial and recreational fishing and pleasure boating. Some of the adverse short-term effects on boaters and fishermen may be offset by long-term benefits associated with safer and more convenient access to harbors and ports. The sights, sounds, and smells associated with dredging and dredge placement operations will create additional short-term aesthetic impacts that are sources of additional costs. Some potential ecological impacts, although not usually described in project documents in terms of economic costs, may also generate significant ancillary costs. These include potential impacts on food chains, foraging behavior, migratory patterns, and the availability and catchability of fish.

Although the incremental environmental costs associated with this or any other specific dredging project may be relatively low, the cumulative costs associated with the environmental impacts from many dredging projects can be significant. Besides the incremental costs of each project, in other words, each project also contributes to a higher overall risk of catastrophic environmental changes that could result in significant economic costs (e.g., fishery collapse, public health alerts). The adverse environmental impacts of these projects also reduce the expected environmental and economic payoff from public investments and volunteer efforts to restore bay resources.

Lastly there are issues related to the distribution of costs. These issues and related issues involving mitigation are not usually addressed explicitly in formal benefit cost analysis. For example, if one dredging option results in $100,000 less dredging costs than another, but also results in fishery impacts that cost fishermen $100,000 more than the other option, the overall costs of the two options are identical. In such a case equity considerations might favor having those involved in dredging and presumably benefiting from it, pay the extra $100,000 associated with the second option rather than impose $100,000 in costs on fishermen.

However, what if the cost of the option that avoids the $100,000 in fishery impacts is $1 million more expensive? Based on benefit-cost analysis or cost-effectiveness analysis, it would not make economic sense to argue for the higher cost option. However, unless the fishermen are compensated, selecting the lower cost option results in an overall cost savings of $900,000, but a net $100,000 economic losses to fishermen. There may be many others besides fishermen (e.g., pleasure boaters, skindivers) who incur economic losses as a result of choosing the low cost option, even if the costs imposed on all of them collectively do not justify selecting the higher cost option. Mitigation and compensation are difficult issues that cannot rely solely on economic arguments. However, there are clearly cases where the net benefits of a dredging project (benefits less costs) will be higher with compensation and compensatory mitigation than without. In some cases it is possible to mitigate economic impacts on other user groups by investing in compensatory habitat restoration. To make things win-win, compensation should be paid.

Although the environmental and economic analysis of this project is generally viewed as being thorough and fair, there remains some opposition to dredging in general and to the Preferred Alternative in particular. In most cases opponents are requesting that further analyses be completed to address three specific issues:

(1) the need for the project (e.g., Would a multi-fuel pipeline from Quonset Point really make more economic or environmental sense than dredging?)

(2) the potential impact of open-water placement on fish resources and commercial fishing (e.g., Will the project affect fish abundance or availability or the outcome of lobster habitat restoration?)

(3) the feasibility of alternatives that do not involve open-water placement (e.g., Is the cost of upland placement really prohibitive?)

Discussions with those involved in developing and analyzing options suggest that more detailed analyses of options that are highly improbable (e.g., a pipeline) are unnecessary and wasteful of tax dollars. There is some sentiment that those calling for additional research prior to implementing the plan are merely attempting to delay the start date. These delays, project advocates claim, will then be used by opponents of the project to argue for further delays since by the time more analysis of these options is complete research related to other topics will be outdated and need to be redone.

VI.G.3. Evaluation of Economic Arguments Used

U.S. ports compete aggressively with one another for shipping business. Keeping access channels dredged to accommodate modern deep-draft vessels is a necessary condition for ports to be competitive. However, investments in dredging in no way guarantee that a port will keep customers or will attract current or future shipping business away from other ports. Many other factors, such as the condition and availability of harbor facilities, labor costs, access to truck and rail routes, proximity to buyers and sellers, state environmental regulations, and dockage and offloading fees are all important considerations when a shipper is selecting (or investing in) a port.

Competing ports are also likely to respond to dredging and related investments by taking their own initiatives (e.g., investing in new facilities or lowering charges) to prevent losing business. Not all ports can win, and although this interport competition results in an extremely efficient U.S. port system in terms of cargo handling, it also results in significant economic waste in terms of investments in dredging and port development projects that never pay off in terms of economic benefits. This complicates the economic analysis of dredging and port development projects. Ports do need to maintain adequate channel depths and widths to be competitive. However, they may also need to invest in complementary harbor and port facilities and lower their fees to actually beat the competition, and that may mean that the net economic benefits from investing in dredging never materialize. Economic studies of dredging at a particular port need to focus on the availability of "complementary" forms of capital at that port and the availability of "substitute" port and cargo handling facilities at competing ports.

As the average size of cargo vessels grows and the global shipping industry becomes more consolidated, the opportunities that ocean carriers have to play one port against another port to lower costs have increased significantly. Economies of scale in modern shipping also favor more concentrated shipping activity (e.g., hubs and super ports). All of this makes the benefits from dredging at any particular port more risky and more difficult to forecast than they have been in the past. "Purpose and needs studies" related to all proposed dredging and port development projects provide reasons why proponents believe their port will be successful at keeping business and/or attracting business from other ports. However, few economic analysts have enough information about the investment strategies of other ports or the deals they are making with various ocean carriers and shippers to evaluate which port will be successful in attracting shipping with or without a proposed dredging project.

After examining the information related to this case study, it seems that the benefits of dredging here are far more certain than in most situations. In this case, for example, the issue of inter-port competition is far less important than in most other cases. This is because the economic value of the Port of Providence is based primarily on its role as part of the state's existing energy infrastructure, not on its competitive position with respect to vessel or cargo handling. Unless another port develops in the state of Rhode Island, Providence will continue to be at the center of the state's energy delivery system. The only alternative to delivering fuel to fuel storage and distribution facilities in Providence via ship would involve deliveries by truck, rail, or pipeline from other ports. None of these options are tenable in the near-term and all are so unattractive in terms of economic costs and environmental impacts that they are not being considered seriously. The benefits of this dredging project, in other words, are not as difficult to define as the benefits of most dredging projects because users of this port have few choices but to continue using it. The only economic question is whether the benefits in the following three categories are greater than the dollar costs and environmental costs of completing the proposed dredging.

- cost savings to shippers, and possibly to consumers
- increases in jobs and incomes in port-related businesses
- avoided congestion and wear and tear on highways, and so on.

The costs of dredging are usually described and compared in terms of $ per cubic yard ($\$/yd^3$) and, if based on full cost accounting, include:

- cost of identifying and comparing sites
- cost of meeting permitting and regulatory requirements
- cost of creating confined dredged material placement sites
- cost of undertaking dredging and dredged material placement activities
- cost of long-term monitoring, testing, and site management

From NOAA Fisheries' perspective the important costs are associated with potential dredging impacts on fish and aquatic habitats. Tracing the project-specific and cumulative environmental impacts of dredging projects (e.g., potential impacts on fish habitat and fish abundance and availability) is extremely difficult and costly. Attempting to assign dollar values to these potential impacts (e.g., lost fishermen earnings, higher fish prices, lower "willingness to pay" for recreational fishing) is also difficult and costly. Moreover, these costs, even if they were measured generously, would usually be so small in relation to other project costs that they rarely would have any impact on the selection of dredging options.

An initial screening by the USCOE of marine disposal sites narrowed consideration to seven sites—four in Narragansett Bay and three in Rhode Island Sound. Each site was selected, at least in part, because it had sediment characteristics similar to those of some of the material being dredged. Using available site-specific biological data, an economic analysis estimated the short-term, long-term, and indirect (food web) costs to commercial and recreational fisheries of disposing of dredged material at seven possible sites (Grigalunas, Opaluch and Luo, 2001). The results showed that disposal at sites in Narragansett Bay resulted in substantially higher costs to fisheries than potential disposal sites in Rhode Island Sound. Some commercial interests continue to argue that the placement site that was eventually recommended is in an area that serves as a "highway" for fish and crustaceans and that disposal of material at that site would impact fishing beyond the adverse impacts that were estimated in the USACE-funded economic studies. Although the claims of these fishermen may be justified, neither the fishermen organizations nor NOAA Fisheries have provided studies to show that the impacts at the proposed site are significantly higher than the USACE estimates.

The USACE sponsored studies to predict the exposure of fish to sediment plumes from dredging and the additional mortality it would cause. It then sponsored a study where the formula that NOAA Fisheries uses to settle natural resource damage cases was used to estimate the long-term losses to fishermen from the predicted effects on fish larvae and juvenile and adult fish. Even with generous assumptions (e.g., all larvae would enter the commercial fishery) these indirect economic costs from dredging totaled $60,000.

VI.G.4 Economic Issues Not Considered

Benefit/cost analyses of proposed dredging projects frequently ignore or assume away important economic issues that involve shifting patterns of shipping and world trade and the effects of inter-port competition. However, most of these economic issues are relatively unimportant in the case of the Providence River dredging project and can be ignored. The critical role of the Port of Providence in the state's energy delivery system and the lack of any viable land-based or water-based alternatives for delivering fuel to storage facilities in Providence make maintenance dredging of the channel relatively easy to justify. Few interest groups actually oppose the project or have called for more economic justification. Because the project will reduce environmental risks posed by shoaling (e.g., risks of oil spills), even environmental advocates see some benefits from dredging.

On the other hand, there are outstanding questions about the criteria that the USACE used to select the preferred options for dredging and dredge material management. Some interest groups still question why technologically feasible options that further reduce or eliminate potential fishery-related risks were rejected. These issues tend to be characterized in project documents primarily as environmental issues, not economic issues. However, the critical question here boils down to how the USACE determined that the benefits of further modifying dredging activity to avoid certain marine resource impacts or risks were not worth the dollar costs. Similarly, options that involved beneficial uses of dredged material to restore wetlands, islands, and reefs were rejected as being too risky and too costly. Although there is general consensus that these beneficial use options probably were too risky and costly given the current state of technology, there are lingering questions about how much research went into answering questions about costs, risks, and potential environmental benefits associated with these options. Unless directed research is undertaken to develop and test low-cost technologies to undertake beneficial use projects (e.g. wetland layering, reef construction), these options will continue to be rejected as being too experimental, too costly, too risky, and so on. In this case, for example, it would have been instructive to apply modern methods of ecosystem valuation in combination with conventional methods of investment, production, and portfolio analysis to evaluate the costs, risks, and benefits of proposed beneficial use projects.

It is never possible to perform research to answer all questions about the potential risks to fish resources or potential losses to fishermen from all dredging and dredge placement options.

However, interviews and reviews of project documents indicate that enormous effort went into identifying and evaluating sites, measuring costs and benefits, and selecting options. We did not identify any important economic issues that were ignored. However, there were two economic issues that were mentioned in project documents, but seemed to have received less attention than they deserved. First, the beneficial impacts of the proposed dredging at marinas on marina and boatyard operators, ancillary businesses, and recreational boaters could have been more clearly defined and quantified. This could be accomplished by characterizing the affected groups and applying various benefit transfer methods. Second, the method used to estimate the cost of delaying dredging to accommodate dredging windows and/or complete additional research could have been improved. These costs were measured in project documents using the foregone interest on the money invested in the project. Delays do not change the opportunity costs of that money. It would have been more appropriate to measure delay costs using the discounted value of the lost net benefits due to the delays. These would include any additional dredging costs caused by the disruptions as well as any lost project benefits associated with delays. If the delays result in additional potential costs, for example, by discouraging private investments in harbor facilities or by resulting in lost shipping contracts for the port, these could also have been identified.

Project documents indicate that lower shipping costs associated with the project are likely to be passed along to Rhode Island consumers in terms of lower gasoline and home heating fuel prices. Considering that importers already have 97% of the Rhode Island market for these commodities at current prices, it is difficult to understand why they would lower prices to consumers rather than use lower shipping costs to increase their profits. The willingness of those supplying fuel products to Providence by ship to lower prices depends on the availability of competitively priced fuel from competing sources (e.g., road and rail) which project documents argue convincingly do not exist. The assertion that lower shipping costs will result in lower regional energy costs needs more justification. Will dredging somehow result in more competition among energy suppliers who import through the port?

VI.G.6. Generality

The economic payoffs from dredging projects are inherently risky. Success usually depends on long-term trends in international shipping and trade, labor and environmental issues and, most importantly, the investment and strategic decisions of competing ports. Costs, on the other hand, usually involve known dollar expenditures as well as potentially significant, but difficult to quantify, economic costs associated with adverse and potentially cumulative and irreversible environmental impacts.

The process of identifying and comparing dredging options always involves a tension between groups who are convinced that the projects are essential and are concerned primarily about keeping dredging costs low and completing dredging in a timely fashion, and groups who question if projects are needed and are concerned primarily about adverse environmental impacts and, more recently, about the potential beneficial uses of dredged materials.

This case study is not typical in the sense that the need for the project is generally accepted by all parties and potential competition from other ports is not a significant issue. The case study does show how, under these conditions, the two opposing groups, represented at a technical level by fishery scientists and port engineers, can work together to develop dredging strategies that strike a reasonable balance. The main example of how this collaborative work is succeeding here involves a compromise that resulted in replacing proposed "dredging windows" that would require expensive demobilization and remobilization of dredging equipment in favor of carefully designed "dredge sequencing" that allows continuous dredging, but restricts when and where dredging can take place. Details are still being worked out, but it appears that comparisons of species spawning behavior and dredging needs is allowing a pattern of dredge sequencing (specific monthly dredging locations for each of 18 consecutive months) that most observers believe will provide almost as much protection to essential fish habitat as dredging windows (no dredging during certain months).

Public investments in maintenance dredging to keep working ports efficient and competitive have always been relatively easy to justify using conventional benefit/cost analysis. However, this case study illustrates that the economic analysis required to justify these projects is becoming more complicated, and is beginning to focus on economic issues that are largely unrelated to shipping or trade. The method by which tradeoffs between dredging costs and ecosystem services and values are resolved is beginning to have an enormous effect on the economic feasibility of dredging. Ultimately, this may affect the viability of certain ports. This case study also illustrates, however, that the burden of proof will usually be on those promoting dredging options that protect or restore environmental resources to show that the resulting benefits are greater than the additional costs.

It is important in this regard to realize that the benefit-cost analysis used to justify federally funded dredging projects is based on what is called the "base plan" which is the least-cost dredging option that the USACE determines to be relatively benign in terms of environmental impacts. The benefit-cost analysis of higher cost options that might be chosen because they result in greater environmental benefits needs to stand on its own merits. This means that the added cost of options that use dredged material in beneficial uses such as to restore a wetland or island or reefs, for example, will need to be funded using federal or state money appropriated for those purposes, and not for dredging.

Background materials and interviews for this project indicate that environmental/economic tradeoffs were the focus of considerable research and interagency negotiation and that the resulting preferred dredging plan probably struck a fair balance. However, it is also clear that more information about the value of ecosystem services and the costs and risks, especially those associated with proposed beneficial uses of dredged materials, would have been useful.

Extending the economic analysis of dredging projects to consider the costs and benefits associated with environmentally beneficial uses of dredged material is not without risks. These options, even if they result in benefits that exceed the costs they add to dredging operations, do not usually provide a real source of income or revenue to offset those cost increases. In the face of immediate dredging needs many ports may not be able to afford the time or money to even study these options, much less invest in them, regardless of whether or not the environmental benefits that accrue to the general public exceed the added costs. With this in mind, two other general lessons can be learned from this case study. First, the agencies responsible for keeping shipping channels open, including the USACE and various state and municipal port administrations, will not allow themselves to be viewed as “deep pockets” to support expensive and risky ecosystem restoration projects. Second, the costs of environmental constraints and demands for beneficial environmental uses of dredged materials, for better or worse is likely to change the comparative advantages of certain ports, given how this will effect the cost of dredging at a particular port..

The consolidation of shipping and international trade may provide opportunities for NOAA Fisheries to take an active role in supporting a more cost-efficient and environmentally sound national port policy. It may make sense for NOAA Fisheries to explicitly support investments to dredge and expand port facilities where environmental impacts are low and oppose future investments at ports where the environmental costs are high. It may make sense for NOAA Fisheries to support superports and distribution systems that do not require extensive deep-water dredging at all ports. Finally, the issue of beneficial uses of dredged materials requires more research both in terms of its economic implications for the cost of dredging and the value of the beneficial use.

VI.G.5. Improving the Decision with Economics

VI.G.5.a. Short-Term Improvement

The Providence River project is expected to be approved by the USACE later in 2002, and dredging is expected to begin shortly thereafter, so there is little more that NOAA Fisheries can do to influence dredging or the use of dredged material except to continue ongoing negotiations over dredge sequencing. Environmental mitigation for marine resource impacts of the project should be viewed as an exercise in “risk management” rather than as a process whereby a fixed set of agreed-upon investments are to be completed. The success of these projects depends on how much funding is available to carry them out and to monitor “leading indicators” of success. A “portfolio” of mitigation investments should be considered with spending allowed to shift from project to project as new information is discovered (e.g., about restoration failures or successes elsewhere) or as circumstances change (e.g., invasive species attack the restoration site). Sufficient funds should also be available to support the monitoring of mitigation success to guide other mitigation efforts and to make mid-course corrections. Short-term opportunities still exist for NOAA Fisheries to use integrated cost/risk analysis to help determine the level of spending on mitigation, the selection of mitigation sites and goals, and the management of mitigation projects.

VI.G.5.b. Long-Term Improvements

In all coastal regions where dredging and port development projects pose unavoidable threats to fisheries and marine ecosystems NOAA Fisheries should develop the capacity to critically evaluate all economic assumptions, assertions, and forecasts used to justify these projects. The "needs assessments" used to justify port expansion are too complex to be challenged by natural resource experts within NOAA Fisheries. Similarly, the costs of dredging options and of innovative environmental uses of dredged material are too complex to be understood without directed research. This area of economic research is currently dominated by port engineers and economists who work almost exclusively for port development advocates and who are rarely challenged. NOAA Fisheries should develop the capacity to evaluate port economic analysis if only to reduce the level of suspicion that exists among those who prefer less coastal development and are faced with dozens of economic studies showing why it is essential for economic development, energy independence, and similar type projects.

NOAA Fisheries should have the technical capacity to evaluate, and where possible, help justify alternative development projects that involve fewer adverse impacts. As in the case of port economics, the issues and technical and economic questions are the same for most areas so it may make sense for NOAA Fisheries to centralize, either physically or virtually, the skills and data required to perform dredging needs assessments, benefit-cost analyses, impact assessments, and so on.

VI.H. Case Study Summary

The table below summarizes some of the major economic issues, economic tools and habitat protection benefits discussed in the six case studies.

Project	Issues		Appropriate Economic Tool	Habitat Protection Benefit
OENJ	1	Value of created mudflats is being represented as a 1:1 tradeoff for habitat lost due to diminished value from contamination	Invalid B/C. 1:1 mitigation is uneconomical unless conditions in V.5.2.1 are met	Improved mitigation ratio
	2	Economic benefits of development improperly used to justify no mitigation	Cost-effectiveness. Higher economic benefits would be realized with mitigation, lower without	Improved net cost-effectiveness
	3	Improper placement of risk resulting in net economic loss to public w/o mitigation	Measurement of public risk premium and application to mitigation?	No net loss to public welfare??
Golden Anchor	1	Difficult tradeoff between stakeholders	Structured Decision Analysis allows for potentially greater preservation of habitat over time and space given ultimate buy-in of all stakeholders in the decision process	Recognition of long term environmental benefits and improved implementation of ultimate decision. Improvement in otherwise ad hoc permitting process.
	2	Lack of data linking natural resources identified and resource services of value	See recommendations 1 and 2 on compiling values and conducting research.	Greater protection of most valuable habitat
	3	Lack of consideration of cumulative impacts	See discussion of cumulative impacts in Section II.C.	Economically efficient trade-off of development versus environmental harm
Beach Nourishment	1	Consideration of equity regarding who benefits from beach nourishment	Cost-benefit analysis can reveal who gains and losses	Transparency of decision process makes public aware of tradeoffs.
	2	What is the opportunity cost of sand pumped from offshore	Economic analysis of beach and sediment transport dynamics	The natural functions of offshore sand are considered
Salinas Valley	1	Groundwater is an unpriced resource	Benefits transfer	Water uses are balanced based on true social costs and benefits
	2	Environmental costs not taken into account to their full extent therefore mitigation measures may not cover full extent of environmental costs	Use of structured decision approach to value assessment and stakeholer involvement	Increased long term benefits from protected habitat, credible assessment and implementation of ES mitigation
Quonset Point	1	Measures of economic benefits depends on accounting stance	More realistic needs assessment for new east coast container port	More realistic assessment of economic costs and benefits would most certainly prevent this project and preclude adverse environmental impacts.
	2	Needs assessment is highly questionable	More extensive consideration of public costs, including non-port (road) costs.	Alternative uses may include build-outs that improve fishery conditions and related economic impacts.
	3	Claimed economic impacts are not justifiable	. Ports may need to invest to be competitive, but all ports cannot win by luring the same shippers	Efficient regional port development minimizes impact on habitat.
Providence River	1	Benefits are associated with reduced shipping costs, accrue to shippers	Focus on potential long-term fishery impacts and contribution to potential catastrophic fishery collapse	Provides more justification for project modifications to avoid fishery impacts and for more fishery-related mitigation.

VII. Discussion and Recommendations

To the extent the case studies we reviewed represent situations where NOAA Fisheries must exercise its responsibilities to protect habitat our review indicates that NOAA Fisheries could greatly enhance its stewardship role by incorporating the types of economic approaches mentioned in this report. It is not possible to determine *whether the outcomes of any of* the cases would have been different had more thorough economic analyses been used to develop and justify NOAA Fisheries position or to challenge the positions taken by others. However, the outcomes may have been more favorable to NOAA Fisheries position and, in any case, incorporating more economic analysis, especially to justify more habitat protection, would have improved the decision-making process and increased the likelihood of decisions that would have led to greater net benefits to society.

In general, we found the NOAA Fisheries activities that we reviewed all had economic aspects that were overlooked or given inadequate attention and could have been analyzed in ways that would justify more habitat protection or more mitigation. We identified numerous problems with the type and quality of economic analyses being used by proposers of projects with adverse habitat impacts to justify their projects based on economic benefits and improvements in regional economic conditions.. These claims of improvements in jobs, incomes, taxes, and business sales often have nothing to do with environmental impacts, but they do result in decision-makers and citizens being willing to overlook environmental impacts or accept them, and they need to be challenged. On the project cost side we discovered numerous problems of omission where neither the proposers of projects nor NOAA Fisheries provide very much discussion or analysis related to the economic costs of habitat degradation. Besides specific concerns about the identification and measurement of project benefits and costs, we noted that the issues related to risk and cumulative effects were important in almost every case study and were also given far less attention than they deserve While these topics are often addressed in terms of potential biological impacts, the economic ramifications of these impacts, as discussed in Sections II.B and II.C, needed to be given much more attention.

Much of this report is about economic issues that NOAA has little control over. We believe that an argument has to be made that NOAA Fisheries/NOAA is the trustee for these various resources and must assure that the entire analysis is done properly. Simply doing their own portion of the input will not necessarily result in protecting these resources unless the rest of the analyses are done properly. Since these are beyond the control of NOAA Fisheries, its only choice is to do a critique of the entire analysis.

Incorporating economics into the NOAA Fisheries habitat protection programs in a comprehensive way will require a long-term commitment and investment in infrastructure development. This will need to include internal personnel additions and development as well as strategic alliances with experts outside of NOAA Fisheries who remain prepared to respond rapidly to specific needs and provide professional to NOAA Fisheries.. Specific recommendations for action that were made in various forms in the case studies above include:

1) Develop inventories and comprehensive literature reviews of habitat values to evaluate the existing state of knowledge regarding the value associated with various habitat types.

2) Eliminate the vast gaps (that will be found in task 1 above) in our knowledge regarding economic values of different habitat types in different regions and at different scales through an active research program.

3) Begin a research program that attempts to quantify the risk-related social costs associated with projects with highly uncertain environmental and economic impacts.

4) Create bio-economic models that quantify cumulative effects of habitat degradation and loss, as well as the economic consequences from beneficial uses of dredge materials.

5) Develop regional decision making processes using techniques such as the Structured Decision Approach (section III.C) to develop a comprehensive framework that will guide individual project decisions so that they are not evaluated in isolation from other proposed projects and include a full range of stakeholder objectives and values..

6) Staff NOAA Fisheries headquarters and regions (one economist in each region, coordinated by a headquarters economist) to form a critical mass of economists within the agency working on habitat conservation and protection issues, similar to the staffing strategy for economists working on fisheries management.

7) Coordinate with other NOAA components working on economics of coastal habitat issues (e.g. CZM, Damage Assessment, Coastal Ocean Program, Sea Grant)., and the development of strategic alliances with university centers and non-profit organizations involved in related research.

8) Interact with the Office of Management and Budget to assure that Executive Orders guiding the implementation of benefit-cost analysis and cost-effectiveness analysis reflect the concerns of NOAA Fisheries.1) Development of inventories and comprehensive literature reviews of habitat values to evaluate the existing state of knowledge regarding the value associated with various habitat types.

2) A research program to eliminate the vast gaps (that will be found in task 1 above) in our knowledge regarding economic values of different habitat types in different regions and at different scales.

3) A research program that attempts to quantify the risk-related social costs associated with projects with highly uncertain environmental and economic impacts.

4) Bio-economic modeling to quantify cumulative effects of habitat degradation and loss, as well as the economic consequences from beneficial uses of dredge materials.

5) Development of regional decision making processes using techniques such as the Structured Decision Approach (section III.C) to develop a comprehensive framework that will guide individual project decisions so that they are not evaluated in isolation from other proposed projects and include a full range of stakeholder objectives and values..

6) Staffing of NOAA Fisheries headquarters and regions (one economist in each region, coordinated by a headquarters economist) to form a critical mass of economists within the agency working on habitat conservation and protection issues, similar to the staffing strategy for economists working on fisheries management.

7) Coordination with other NOAA components working on economics of coastal habitat issues (e.g. CZM, Damage Assessment, Coastal Ocean Program, Sea Grant)., and the development of strategic alliances with university centers and non-profit organizations involved in related research.

8) Revisiting the Principles and Standards used for project analysis to ensure that they are applied in an unbiased manner
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